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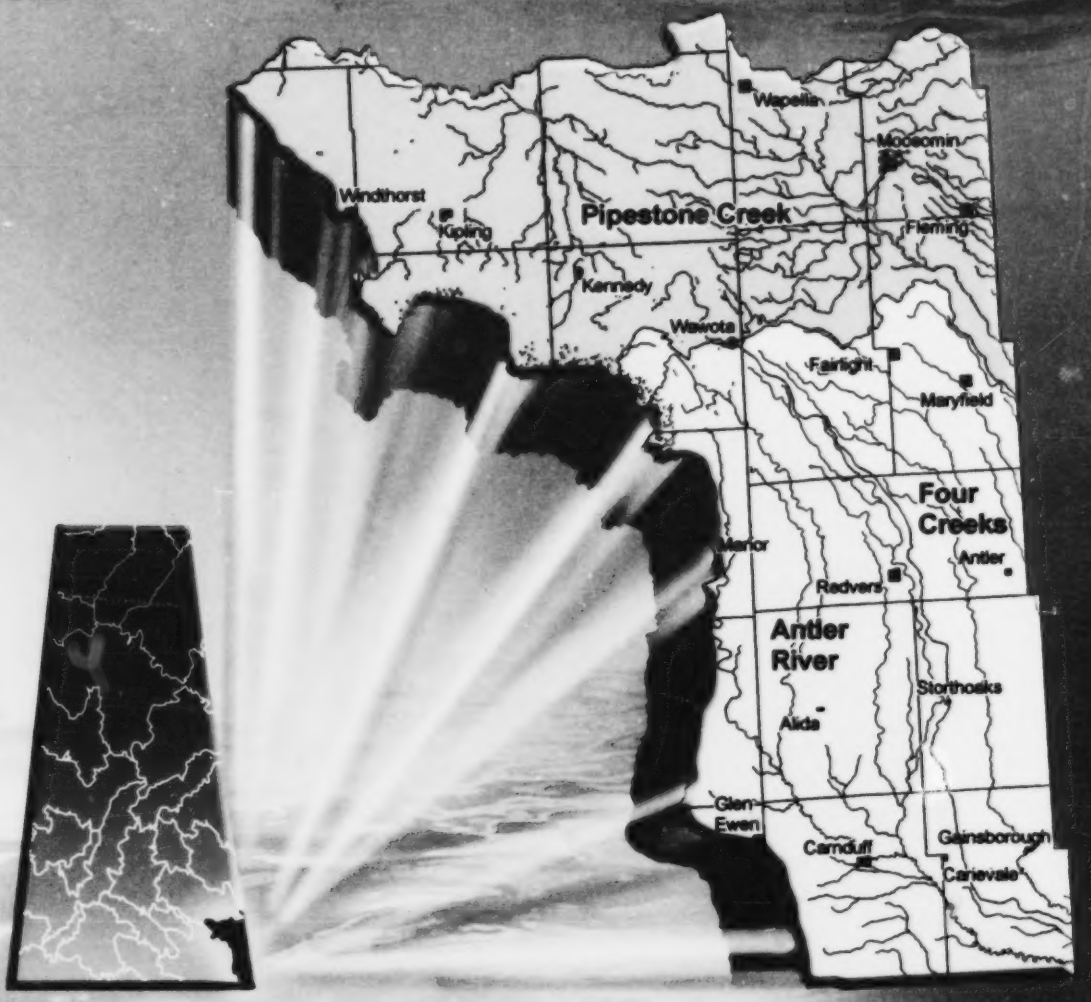
Lower Souris River Watershed

Source Water Protection Plan

March 2006



Saskatchewan Watershed Authority

Lower Souris River Watershed Advisory Committees

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1. Commitment from Participants

1.1 A Message from your Watershed Advisory Committee Chairs

Ross Madsen
Four Creeks Watershed Advisory Committee Chair and Reeve of the Rural Municipality of Antler No. 61

"After six years of meetings and much consultation, with the help of the Four Creeks Watershed Advisory Committee members, R.M. councillors, Jeff Olson, Etienne Soulodre, Collin McGuire and the Technical Committee, we have a management plan to digest, poke holes in, delete or add to. Now is the time to act on many of the recommendations – let us get to it."

John Van Eaton
Pipestone Creek Watershed Advisory Committee Chair and appointee for the Rural Municipality of Maryfield No. 91

"As with most things in life, watershed planning does not benefit from having the pendulum swing all the way to one side or the other. Considering all the interests in a watershed during planning and implementation, we have the greatest chance to succeed if moderation is practiced, with room to adapt to changing conditions."

Warren Steves
Antler River Watershed Advisory Committee Chair and Reeve of the Rural Municipality of Argyle No. 1

"Everyone's goal must be to protect the quality and quantity of clean drinking water for humans, animals and the environment. The goal of the Advisory Committee is to identify potential sources of contamination, whether it be from intensive livestock operations, urban centres, oil and gas operations, or any other potential sources. We need to protect the environment that purifies our water, such as wetlands that are drained unnecessarily. We also need to start monitoring water quality to detect the fertilizers and chemicals coming from farmland runoff in wet years. All of this must be done in a spirit of cooperation with all watershed residents. This watershed plan is the start of the journey to that noble end."

A **watershed** is an area that, because of topographic slope, contributes water to a specified surface water drainage system, such as a stream or river.

1.2 Lower Souris River Watershed Advisory Committees' Mission Statement

"Balancing the economic, environmental, and social values to sustain and improve the watershed for future generations."

1.3 A Message to Watershed Residents from your Watershed Planning Team

The Province of Saskatchewan formally initiated the watershed planning process in the spring of 2003, but local residents had their own ideas about how to protect source water long before that. The 3 Creeks Watershed Board, which included rural municipalities in both Saskatchewan and Manitoba, started gathering the information needed for watershed planning in 1999. A considerable amount of that work is reflected in the Lower Souris River Watershed Background Report. (The Background Report can be downloaded at www.swa.ca, or a hard copy or CD version can be requested from any Saskatchewan Watershed Authority office or by calling 1-866 SASKH2O.) The Moosomin Lake stewardship group monitored water quality in the lake but soon realized that the whole Pipestone Creek Watershed had a lot more to do with water quality than just the area surrounding the lake. It was with this local foresight, vision and initiative in mind that the Lower Souris River Watershed was chosen as one of the first watersheds in Saskatchewan in which to initiate watershed planning. It will be this same leadership, vision and genuine concern for people, the environment and source water protection that will see this plan succeed.

The planning team would like to thank all those that contributed to the development of this plan, and in particular, the three Watershed Advisory Committees whose understanding, perseverance and patience during the process was much appreciated. A special thanks to the chairs of the committees – Ross Madsen, John Van Eaton and Warren Steves – for their leadership, direction and commitment to this planning process, and to Jim Cairns of the Provincial Council of Agriculture Development and Diversification (ADD) Boards for his participation as a co-chair in the Environmental Farm Plan group initiative.

Thanks to the invaluable advice and information provided by the Lower Souris River Watershed Technical Committee, in particular the extraordinary efforts and support of Etienne Soulodre of Projects and Partnerships, Saskatchewan Watershed Authority and Doug Brook of Ducks Unlimited Canada. In addition, thanks go to our colleagues in the Watershed and Aquifer Planning unit, whose insights and mentorship during this new process helped to make it a success.

Also, a special recognition to Glen Campbell and Gregg Fotheringham of the West Souris River Conservation District and Phil Weiss of Manitoba Water Stewardship, whose encouragement and support ensured success not only to the plan but to its implementation. This exemplary inter-provincial co-operation between watershed residents will prove that watershed health is more important than provincial boundaries.

2. Watershed Protection and You

2.1 One Step in the Multi-Barrier Approach to Drinking Water Protection

The drinking water supply can be broken down into three parts: source water, the drinking water treatment system, and the distribution system that carries the treated water to homes, businesses,

schools, and other buildings. As drinking water travels on its journey to you, it could become contaminated in many ways. The multi-barrier approach to managing drinking water supplies is one preventive risk management approach that identifies all these known and potential hazards and makes sure barriers are in place to reduce or eliminate the risk of contamination. The implementation of this Source Water Protection Plan represents the first barrier in protecting source waters. It cannot be stressed enough that source water protection is only the first barrier of defence against waterborne diseases or illnesses. Another key barrier is the routine treatment of water sources, usually by chlorination, and continual removal of unwanted waterborne elements such as bacteria, viruses, and organisms, by means of reverse osmosis, filtering, etc. **The only way of knowing what treatment the water supply needs is to have an expert do a comprehensive test of the source water, and then implement recommended measures to reduce risk.**

Source water is untreated water which will be used for a specified purpose, such as human use and consumption. Examples of source water include lakes, reservoirs, rivers, streams and groundwater. **Source water protection** is the prevention of pollution and sound management of factors and activities that (may) threaten water quality and quantity.

Saskatchewan communities are required to meet strict standards of testing and treatment of their water supplies. The same cannot be said for private water supply systems. Although many people are encouraged to test their water supply, most limit it to the testing available from the Provincial Laboratory for both E. coli and nitrates. As a reflection of this "what we don't know can't hurt us" attitude, almost half of the farm respondents surveyed in the Upper Qu'Appelle River Watershed drank unfiltered water right from the tap (48.5%), and more than half the farms (60.8%) did not have any type of treatment unit or filter on their water system.[1]

Photo courtesy Ducks Unlimited Canada

All watershed residents have an interest in protecting source water and, as such, all should be responsible for the implementation of this Source Water Protection Plan. Everyone should and can do their part. That includes big parts, such as being a councillor for a city or rural municipality which is responsible for the drinking water of hundreds of people, or small parts, such as practising stewardship and testing and treating the water on your own farm. Get involved and do your part!

2.2 Secondary Benefits of Protecting Source Water: Quality and Quantity

2.2.1 Quality

Protecting source water can mean removing and/or reducing known point sources of pollution and accumulative non-point source pollution. Source water protection can also mean maintaining nature's own purification systems and not overloading them.

[1] Saskatchewan Watershed Authority, *Summary of the Water Use Survey in the Upper Qu'Appelle River Watershed,* April 2004

Protecting specific ecosystems such as wetlands that remove contaminants and purify our drinking water also means protecting water for recreational uses such as swimming and boating and for livestock use, as well as for wildlife and fish habitats. Healthy riparian areas remove sedimentation which can carry waterborne chemicals. The uplands are areas that have the most human activity and therefore can potentially affect runoff waters.

There are economic benefits to having higher quality water available in many industries, such as manufacturing and value-added agriculture. Many times a good quality, high quantity water source can be the driving force that entices an industry to locate in a particular area.

When source water is of the highest natural quality, treatment is less costly and less complex. The potential health risks posed by the failure of treatment systems is also reduced.

Riparian areas are zones of vegetation adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby upland areas.

2.2.2 Quantity

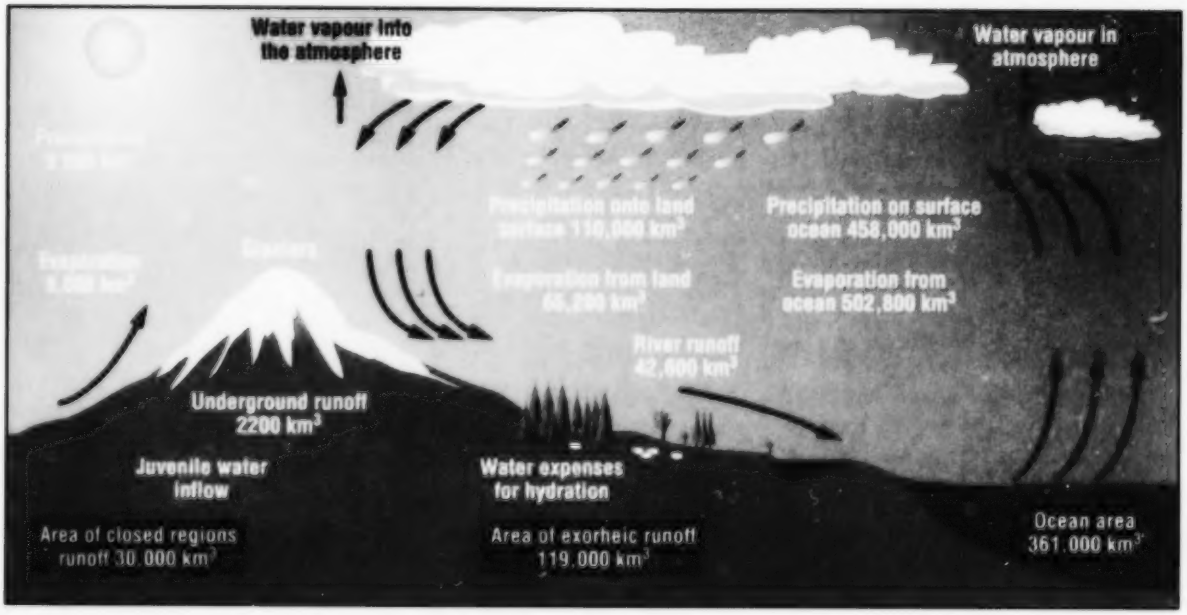
Water is a renewable resource. Different forms of water are fully replenished during the hydrological cycle, but at very different rates. For instance, the period for complete recharge of oceanic waters takes about 2,500 years, permafrost and ice about 10,000 years and deep groundwater and mountainous glaciers 1,500 years. Water storage in lakes is fully replenished over 17 years, and in rivers about every 16 days (see page 5 - water resources renewal chart).

Surface water and groundwater are directly related and form a part of the hydrological cycle (see page 5 - Hydrological Cycle diagram). Groundwater that is close to the surface can be influenced in both quality and quantity by surface activities. Deeper groundwater is usually much less influenced by surface activities.

Ensuring water supplies are available now and in the future means there will be water for people and nature, and requires that we account for fluctuations in supply. While the potential effects of climate change are still being debated, what is not debatable is that there will be droughts, there will be floods, and as such, we should plan to mitigate the effects from these natural occurrences.

Water of Hydrosphere	Period of renewal
World Ocean	2,500 years
Groundwater	1,400 years
Polar ice	9,700 years
Mountain glaciers	1,600 years
Ground ice of the permafrost zone	10,000 years
Lakes	17 years
Bogs	5 years
Soil moisture	1 years
Channel network	16 days
Atmospheric moisture	8 days
Biological water	several hours

Periods of water resources renewal on the Earth. [2]

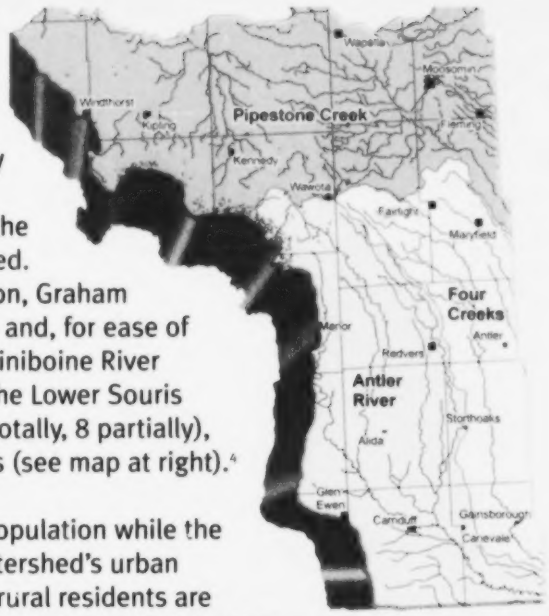

Water vapour into the atmosphere
Water vapour in atmosphere
Precipitation on surface ocean 458,000 km³
Evaporation from ocean 502,800 km³
River runoff 42,600 km³
Underground runoff 2200 km³
Juvenile water inflow
Water expenses for hydration
Area of closed regions runoff 30,000 km³
Area of exorheic runoff 119,000 km³
Ocean area 361,000 km³

Hydrological Cycle [3]

[2] *http://www.unesco.org/science/waterday2000/Cycle.htm November 15, 2005*

[3] *http://www.unesco.org/science/waterday2000/Cycle.htm*

3. Lower Souris River Watershed



The Lower Souris River Watershed is a conglomeration of smaller watersheds that eventually flow into the Souris River in Manitoba. These watersheds include the Pipestone Creek Watershed, the Antler River Watershed, and the Four Creeks Watershed. The Four Creeks Watershed contains the Stony, Jackson, Graham and Gainsborough Creeks occurring in Saskatchewan and, for ease of watershed planning, a small portion of the Upper Assiniboine River Watershed occurring south of the Qu'Appelle River. The Lower Souris River Watershed includes 20 rural municipalities (12 totally, 8 partially), 19 urban municipalities, and three First Nations' lands (see map at right).[4]

The rural population accounts for 37 percent of the population while the remaining 63 percent of the population live in the watershed's urban communities. The majority of communities and most rural residents are dependant on groundwater wells to meet their water supply needs, including drinking water. Many of the community groundwater wells are under the direct influence of surface water.[5] The importance of co-operation between rural and urban residents in ensuring a safe and adequate source water supply cannot be stressed enough.

Stewardship is caring for land and associated resources and maintaining healthy ecosystems for future generations.

Historically, the Lower Souris River Watershed was dominated by fescue grasslands and aspen parkland. Conversion to agricultural land use has resulted in increased amounts of sediment and nutrients leaving the land and entering the aquatic system. Land use in the watershed is currently 80 percent cropland, 10 percent grassland, four percent shrubs, three percent trees, and two percent marsh.[6] Riparian areas have been eliminated or diminished to narrow corridors along the tributaries, streams and rivers. With this in mind, rural landowners and agricultural producers will be key participants in restoration and protection of the watershed. Their individual and collective actions in response to this plan are a critical element of its success.

4. Watershed Planning Methodology

Consistent with Saskatchewan's *Long Term Safe Drinking Water Strategy*,[7] the purpose of the Lower Souris River Watershed Source Water Protection Plan, as the first barrier of defence to protecting drinking water, is to identify the threats and opportunities around protecting source waters in the watershed, and provide a plan to address these threats and take advantage of opportunities.

[4] Population Map, *Lower Souris River Watershed Background Report*, November 2005
[5] Municipal Water Supply, *Lower Souris River Watershed Background Report*, November 2005
[6] Landcover Map, *Lower Souris River Watershed Background Report*, November 2005
[7] Province of Saskatchewan, April 2003

To facilitate planning and encourage local participation, the Lower Souris River Watershed was divided into the Antler River, Four Creeks and Pipestone Creek watershed planning areas. Activities involving watershed stewardship had already been underway in the Four Creeks Watershed since 1999, and in the Moosomin Reservoir/Pipestone Creek Watershed since 2002. The Lower Souris River Watershed Source Water Protection Plan was developed by the local advisory committees in each watershed planning area with critical support from the Lower Souris River Watershed Technical Committee.

The membership of the Watershed Advisory Committees includes representatives from local municipalities, First Nations, and industry, environmental and agricultural interest organizations. Technical support was provided by a variety of government agencies and from Ducks Unlimited Canada. (Participant lists for all committees can be found in the Appendix.)

In support of the planning process, the Lower Souris River Watershed Background Report was developed to provide everyone with a collective understanding of the watershed. This report provides a wide range of information to help build awareness of the many factors that affect the watershed and, ultimately, the quantity and quality of the water. The watershed is described in terms of its physical characteristics, ecology, land use, climate population demographics, and major economic activities, which include agriculture, tourism and recreation, and industry. Water resources are related in terms of quantity, quality, allocation and use. Different land cover functions are described for upland, riparian and wetland habitats. Watershed management is explained by municipal planning and zoning, federal and provincial legislation, stewardship activities, and funding.

This Source Water Protection Plan identifies threats to source waters and provides strategies to address these threats. The plan was formulated using a consensus approach, with all objectives, recommendations and key actions decided by all the Watershed Advisory Committee members. Specifically, this plan assembled pertinent information, analyzed threats and opportunities, built commitments to protect source water, and summarized the Committee's discussions and technical analysis in a number of recommendations. Finally, key actions were formulated from recommendations to be implemented, stating their implementation date and the agency or agencies responsible.

This plan is a living document that can be changed, altered or adapted to suit the needs of watershed residents through the input of the local Watershed Advisory Committees.

5. Interests and Issues

All three Watershed Advisory Committees identified a variety of interests and issues surrounding source water protection in the watershed. Some issues were unique to the individual watershed planning area, while others were common to all. After information was given to the Watershed Advisory Committees and presentations were made by Technical Committee members, some issues and interests were discarded, as they were determined to be either invalid (perception versus reality) or of very low concern and interest. The following chart identifies issues in the entire Lower Souris River Watershed and indicates which Watershed Advisory Committee initiated the issue.

Most of the interests and issues below are interconnected. This is to be expected, as a watershed represents a complex interdependency of relationships.

	Antler River	Four Creeks	Pipestone Creek
Watershed Education	■	■	■
Groundwater Threats and Protection	■	■	■
Community Water Supplies	■	■	■
Water Quality Monitoring and Moosomin Reservoir	■	■	■
Landfills (Waste Disposal Ground)	■	■	■
Municipal Sewage Lagoons	■	■	■
Agricultural Activities	■	■	■
Watershed Management		■	
Fish Migration and Habitat			■
Water Supply for Small Communities	■		
Auburton Reservoir Potential Spillway Failure	■		
Operation of Moosomin Dam			■
Water Conservation		■	

6. Planning Objectives and Recommendations

The Lower Souris River Watershed Advisory Committees have identified the following objectives, recommendations and key actions. The lead agency responsible for the key action is indicated in bold.

6.1 Watershed Education

Photo courtesy Ducks Unlimited Canada

People often take good quality abundant water for granted. They do not always understand how their actions affect the water, or how good stewardship and land-use practices can be implemented to maintain and improve their water.

Educational programs can raise awareness of watershed issues and change the values and beliefs people have regarding watershed resources. This attitudinal change prefaces behavioural change; people generally try to be consistent in their attitudes and behaviours. Changing behaviour is fundamental to promoting sustainability, as the cumulative impact of individual and group actions far outweighs what can be accomplished through the management of agencies such as the Saskatchewan Watershed Authority.

Objective:

To increase the watershed residents' knowledge and awareness of the intrinsic and economic value of water and how they can protect the quality of water.

Recommendations:

- Support WET (Water Education for Teachers), which focuses on school students.
- Support the "Living by Water" program, which focuses on cottage owners.
- Support 4-H program camps.
- Distribute watershed information to rural municipalities, villages, towns, schools, libraries, etc.
- Provide water "manuals" to people with wells to help them better understand how to protect their water supply.
- Provide shock chlorination fact sheets to watershed residents.
- Provide wellhead protection information to watershed residents.

Key Action: Develop and implement an education and communication strategy within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	**November 1, 2006**	**Lower Souris River Watershed Board** Saskatchewan Watershed Authority - Marketing and Education Ducks Unlimited Canada

Key Action: Initiate a focus group and survey to track success of the education and communication strategy within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	**November 1, 2006 (Repeat in 2009)**	**Saskatchewan Watershed Authority - Marketing and Education**

Success Measurement:

Reconvene a similar focus group in ten years and measure any increase in the focus group's awareness of the watershed.[8]

6.2 Groundwater Threats and Protection

Measuring groundwater quality is generally a difficult task. The amount of groundwater data is limited in the Lower Souris River Watershed. The actual quantity of water available for use is difficult and expensive to estimate, while resources available for groundwater research are limited. Groundwater can be contaminated from numerous activities or sources, including oil and gas exploration and production, gravel extraction, septic systems, and agriculture practices. Generally speaking, the deeper the groundwater source is located, the less potential there is for the quality of the water to be impacted by surface activities.

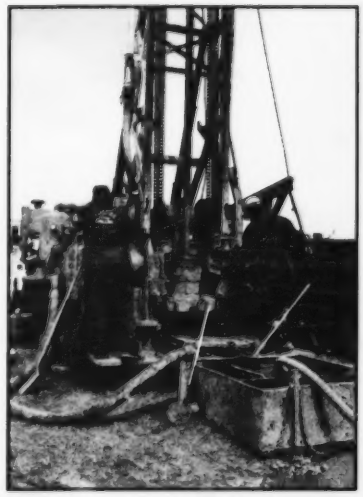


Photo courtesy Prairie Farm Rehabilitation Administration

[8] One of Saskatchewan Watershed Authority's *State of the Watershed Reporting Framework* indicators

The primary domestic groundwater zone used for drinking water is the near-surface zone, where groundwater is more directly and efficiently connected to precipitation and surface water features. Aquifers in this zone are more prone to drought and more vulnerable to contamination from surface activities, although the general water quality is usually less mineralized than water from deeper sources. Aquifers in this zone are used primarily for domestic supplies because they have limited well yields. Surface water bodies, including lakes, rivers and wetlands, can serve as either recharge or discharge areas for groundwater, depending on the local hydrogeology.

Groundwater is, generally, all subsurface water as distinct from surface water; specifically, the part that is in the saturated zone of a defined aquifer – an underground layer of porous rock, sand, or gravel containing large amounts of water.

Wellhead protection includes protecting the "capture zone" of a well from contamination, including direct contamination from activities in close proximity to the well. Good wellhead protection practices include the prevention of the reverse contamination of water supplies by back-flows and cross-connections. Once contaminated, groundwater is not easily restored to its former condition.

Groundwater is the primary water source of drinking water for the majority of communities and rural residents within the watershed. Source water protection of both the quality and quantity of groundwater is extremely important.

Objective:

- To protect groundwater from contamination.

Recommendations:

- Determine any additional groundwater threats not yet identified.
- Determine the relative risk of groundwater contamination.
- Develop a risk analysis model for groundwater that can be applied to all contamination threats.
- Develop a groundwater risks map.
- Develop an abandoned water well program.
- Continue to support existing wellhead protection information programs.
- Establish workshops for residents which demonstrate how to properly locate, construct and maintain well water supply systems.
- Cost-share in properly sealing abandoned water wells.
- Promote the Saskatchewan Watershed Authority's Rural Water Quality Advisory Program among rural residents of the watershed.

- Provide educational information on:
  - the effects of improperly sealed shot holes to seismic exploration companies; and
  - the legal requirements of seismic operations concerning shot hole use and abandonment.
- Locate and quantify aquifers within the watershed.

Key Action: Develop an abandoned well program within the watershed.

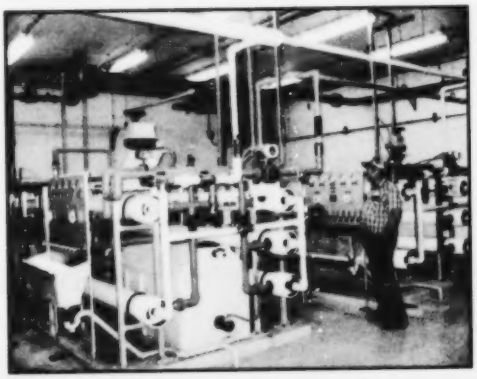
Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2007	Saskatchewan Watershed Authority - Groundwater Management; Regional Operations, Weyburn Prairie Farm Rehabilitation Administration Lower Souris River Watershed Board

Key Action: Develop an informational package on how the oil and gas industry protects the watershed's source water.

Implementation Date	Completion date	Responsibility
January 1, 2006	April 1, 2006	Canadian Association of Petroleum Producers Saskatchewan Industry and Resources

6.3 Community Water Supplies

For most communities, source water is tested to determine proper water treatment. Any failure in the treatment process can result in potential contamination of drinking water. In order to reduce the health risks due to such failures, source water should be of the highest natural quality. Man-made contamination risks can be reduced or eliminated through good stewardship practices and wellhead protection.



The Saskatchewan Watershed Authority is presently evaluating groundwater risks for communities in the Lower Souris River Watershed. This evaluation is scheduled for completion in the spring of 2006. Provincial agencies such as Saskatchewan Environment and Saskatchewan Government Relations are also looking into tools that could be used to protect source water in the future. These initiatives will be a major advancement in the knowledge and preventative actions required to protect community water wells from contamination.

Objective:

To protect community water wells from contamination.

Recommendation:

Develop a methodology to determine the relative vulnerability of community source water supplies.

Key Action: Develop a groundwater risks methodology for community wells within the watershed.

Implementation Date	Completion date	Responsibility
In progress	March 31, 2007	Saskatchewan Watershed Authority - Regional Operations, Weyburn; Projects and Partnerships

Key Action: Develop a wellhead integrity program within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2009	Saskatchewan Watershed Authority - Groundwater Management; Regional Operations, Weyburn; Projects and Partnerships; Watershed and Aquifer Planning Lower Souris River Watershed Board

Success Measurement:
All communities understand the threats to their groundwater and take steps to reduce them.

6.4 Water Quality Monitoring and Moosomin Reservoir

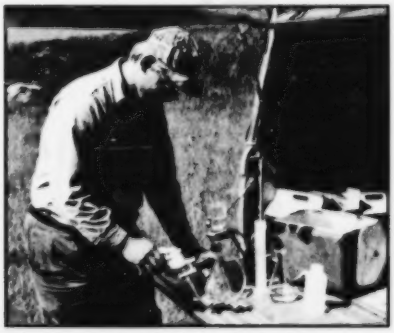


Photo courtesy Ducks Unlimited Canada

Water quality sampling in the Lower Souris River Watershed has been limited and mainly corresponds to municipal wastewater effluent releases. The exception is Moosomin Reservoir, which has a data set that permits interpretation. The Water Quality Index score for Moosomin Reservoir is in the "fair" range.[9] Three parameters are largely responsible for this Water Quality Index rating for Moosomin Reservoir. They are total phosphorous, total dissolved solids (TDS) and chlorophyll *a*.

Increased stream velocity will cause natural erosion of stream banks and channels, adding soil that contains natural phosphorous. Total dissolved solids (TDS) are a measure of the amount of dissolved substances in the water. Sources of dissolved substances include soil erosion, discharge of waste municipal and industrial agricultural runoff, and groundwater (springs). Chlorophyll *a* is a green pigment found in plants and is used to measure the quantity of algae in a water body.

The **Water Quality Index** is a means to summarize large amounts of water quality data into simple terms (i.e., excellent, good, fair, marginal, poor) for consistent reporting.

It may not be cost effective to develop a comprehensive water quality monitoring program. Moreover, these programs may show the condition of the water but not necessarily why the water is in that condition. Using knowledge from other watersheds in North America, we know the type of activities that can degrade water quality and how to mitigate those activities. Ultimately, everyone wants to know the answer to the question: "Is what we are doing having any long-term influence on water quality?" Targeted water quality testing may give us this answer.

[9] Water Quality Section, Lower Souris River Watershed Background Report, November 2005

Objectives:

- To reduce levels of total phosphorous, total dissolved solids (TDS) and chlorophyll *a* by 25 percent within the next 10 years.
- To determine the cause of water quality deterioration in the Moosomin Re ervoir.

Recommendations:

Conduct water quality monitoring in the watershed to determine the present state of the water quality and track changes in water quality over time.

Key Action: Develop a source water quality monitoring plan to track phosphorus, TDS, and chlorophyll *a* levels in the watershed planning areas.

Implementation Date	**Completion date**	**Lead Responsibility** (Partners)
April 1, 2006	**March 31, 2007**	**Saskatchewan Watershed Authority - Monitoring and Assessment Branch** Saskatchewan Environment Saskatchewan Health

Success Measurement:

1. Total phosphorous, total dissolved solids (TDS) and chlorophyll *a* are reduced on an average of 25 percent within the next 10 years.
2. The Water Quality Index rating for Moosomin Lake improves from consistently "fair" to consistently "good" within the next 10 years.

6.5 Landfills (Waste Disposal Ground)

Landfills are potential contaminators of both groundwater and surface water. The extent and potential risk of contamination is directly determined by local geological characteristics of the individual landfill.

Landfills contain high levels of contaminants. Over time communities have learned what not to put in landfills. The licensing of landfills has improved landfill use, but there remains an unknown level of threat to water quality.

Photo courtesy Saskatchewan Environment

Objective:

To determine the relative risk of landfills to both groundwater and surface water.

Recommendations:

- **Identify all abandoned landfills in the watershed.**
- **Develop a risk analysis model that can be applied to all landfills to protect public water supplies.**

Key Action: Determine the level of risk to source water within the watershed from community landfills.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2009	Saskatchewan Environment

Key Action: Develop a database of all existing and abandoned landfills within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2009	Saskatchewan Environment Urban and Rural Municipalities

Success Measurement:
All communities understand the threat to their source water posed by landfills and, if necessary, take steps to reduce those risks.

6.6 Municipal Sewage Lagoons

Sewage lagoons can adversely affect both groundwater and surface water through ground leaching and wastewater releases. Municipal wastewater effluent discharge is one of the largest causes of point-source pollution, by volume, to surface water in Canada.[10] Some municipal lagoons were established before their general environmental impacts to water were known. The extent of the relative risk they present is generally unknown. The risk of groundwater contamination by nitrates can be very high.

Disposal of sewage by general collection and placement in a tertiary lagoon system is an accepted practice. Some communities need to release liquid effluent annually or biannually into a wetland, watercourse, stream or river. This effluent lowers the quality of the receiving waters and is potentially undesirable unless the receiving water has adequate assimilative capacity. Due to climate variance, effluent may not even reach watercourses in some dry years that it would reach in wet years. Some communities have also shrunk in size to the point that they no longer need to discharge, and the system effectively operates as an evaporative lagoon. In other cases, effluent irrigation or exfiltration is used from the secondary/storage cell or an actual evaporative system is in place.

Assimilative capacity is the ability of a water body to cleanse itself, or its capacity to receive waste waters or toxic materials without harmful effects and without damage to aquatic life or humans who consume the water.

Objective:
To determine the relative risk of municipal lagoons to water supplies.

Recommendations:
- Identify the location of all municipal lagoons in the watershed.
- Identify which lagoons release effluent.
- Determine whether lagoons are having any affect on groundwater or surface water.

[10] Environment Canada, 2004.

Key Action: Determine the level of risk to source water within the watershed from community lagoons.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2007	Saskatchewan Environment

Success Measurement: All communities understand the risk to their source water posed by lagoons and wastewater effluent and, if necessary, take steps to reduce those risks.

6.7 Agricultural Activities

Agricultural activities take place on more than 99 percent of the land within the Lower Souris River Watershed.[11] Cropland accounts for approximately 80 percent of the landcover use in the watershed.[12] With this in mind, cropping practices have a significant influence on the quality of water. Agricultural threats to source water can be categorized as either point source or non-point source.

Potential point source threats from agricultural activities can include intensive livestock operations, manure storage, livestock wintering areas, chemical storage and disposal areas, septic systems, and fuel storage. Some potential non-point source agricultural threats include livestock grazing, chemical, fertilizer and manure application, and land drainage, which adversely affects surface water and directly or indirectly affects nature's ability to purify water. Many of these potential point and non-point pollution sources can be identified and addressed on individual farms through the completion of an Environmental Farm Plan.

Point source pollution can be traced back to a specific source such as an oil spill, a discharge pipe or a sewage ditch.

Non-point source pollution cannot be traced back to a specific source. Non-point source pollution is difficult to identify because it can occur any place activities disturb land or water. Agriculture, urban runoff, forestry, grazing, septic systems, construction, recreational boating, careless household management, and sediment from eroding stream banks can all contribute to this type of pollution.

Accumulative effects from non-point sources are of the greatest potential concern because they are largely from activities that, by themselves, do not appear very harmful. However, when these activities occur collectively within a significant portion of the watershed, they can have major effects on water quality and the larger environment. The drainage of wetlands is one example. While the loss of one wetland is not necessarily significant to the watershed, the collective loss of a significant amount of wetlands in the watershed can mean losing the benefits they provide, such as moderation of downstream flooding, groundwater recharge, nutrient absorption, carbon sinks, and wildlife and fish habitat.

[11] Land Tenure Map, *Lower Souris River Watershed Background Report*, November 2005
[12] Landcover Map, *Lower Souris River Watershed Background Report*, November 2005

Objective:

To minimize the agricultural impacts to surface and ground source water within the watershed.

Recommendations:

- Provide annual recognition to local producers that practice good stewardship of their land.[13]
- Provide educational information to local producers on:
  - beneficial management farming practices that limit the amount of nutrient and chemical residues transported during spring runoff or in high rainfall events.
  - economical and environmental beneficial grazing management practices.
  - the benefits of conservation tillage programs.
  - the benefits of grassed waterways in protecting water quality.
  - the benefits of wetlands to surface water quality and ground water recharge.
  - saline tolerant grass seed provided to cereal crop farmers.
  - the benefits of fall seeded crops.
  - manure storage and handling by intensive livestock operations.
  - land drainage, i.e.: regulations, rights and responsibilities, and the effects of land drainage on people and the environment.

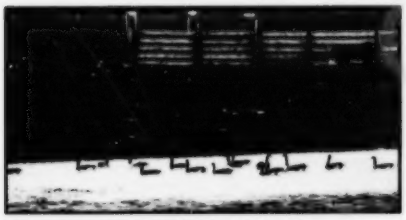


Photo courtesy Ducks Unlimited Canada

- Establish annual grazing management workshops, field days and seminars to promote protection of riparian areas without duplicating existing programs.
- Cost-share with landowners to establish grassed waterways and vegetation buffers to control erosion, slow runoff and filter chemicals and nutrients from runoff.
- Initiate a pilot project showcasing grazing of Fish & Wildlife Development Fund lands as a beneficial management practice demonstration opportunity in the Graham Creek area.

A **wetland** is an area that is saturated by surface or ground water, with vegetation adapted for life under those soil conditions, as swamps, bogs, fens, marshes, and estuaries. Wetlands are a source of water, forage, and wildlife habitat, and perform a number of important functions such as groundwater recharge, water storage, flood control, sediment and residue trapping, shoreline protection, and nutrient cycling and storage.

Key Action: Support the agricultural Beneficial Management Practices of the Lower Souris River Green Plan initiative.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2009	Lower Souris River Watershed Board

Key Actions: Develop a fact sheet on agricultural drainage and farm water management within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	March 31, 2007	Saskatchewan Watershed Authority - Regional Operations, Weyburn Lower Souris River Watershed Board

[13] This has already been established in two of the watershed planning areas.

Success Measurement:

1. Have a minimum of 20 percent of all landowners within the watershed complete an Environmental Farm Plan by 2010.
2. By 2010, see an overall improvement of 20 percent to Riparian Health, Riparian Buffer, Rangeland Health, and Permanent Cover as measured by "*State of the Watershed Reporting Framework*" indicators by 2010.

6.8 Watershed Management

Photo courtesy Ducks Unlimited Canada

The management of water is a multi-faceted responsibility that includes local people and the municipal, provincial and federal governments. Water management decisions affect local people and are too important to not have some type of public involvement in the decision-making process.

Recommendations:

- **Create a Lower Souris River Watershed Board and continue the Watershed Advisory Committees in all three watershed planning areas to provide advice on water management decisions in the watershed.**
- **Amend provincial legislation to allow for more flexibility in implementing local water management decisions.**
- **Analyze waterway capacity, which would include creating an inventory of all infrastructure including culverts, bridges, streams and ditches in the Four Creeks watershed planning area. (At present, only the Rural Municipality of Antler No. 61 has done any of this work.)**
- **Use the water capacity analysis to bring pressure to bear on those agencies responsible for infrastructure (e.g. the culverts used at Highway 18 west of Gainsborough) to modify culvert/watercourse capacities to meet the standard design event chosen.**
- **Determine a standard design event for the system that would balance the infrastructure to handle the design event.**
- **Investigate the feasibility of controlling spring flows of water to buffer downstream peaks through gated culverts, thereby lowering the potential risk for environmental impacts due to flooding.**
- **Address agricultural flooding by investigating, promoting and offering programs to slow runoff, enabling greater water infiltration (i.e., water flow controls, ditch check structures, vegetation establishment).**
- **Address agricultural flooding by considering road design that incorporates ditches that carry runoff water, rather than the present system of moving unwanted water through ditches on private lands.**

Objective:

To have greater involvement of local people in watershed management decisions within the watershed.

Key Action: Create the Lower Souris River Watershed Board and continue the Watershed Advisory Committees in all three watershed planning areas to provide advice on water management decisions in the watershed.

Implementation Date	Completion date	Responsibility
In progress	April 1, 2006	Lower Souris Watershed Board Saskatchewan Watershed Authority

Key Action: Develop a drainage and wetlands policy within the Four Creeks watershed planning area.

Implementation Date	Completion date	Responsibility
In progress	April 1, 2006	Saskatchewan Watershed Authority - Policy; Regional Operations, Weyburn Four Creeks Watershed Advisory Committee

Key Action: Conduct a drainage and wetland inventory needs assessment in the Four Creeks watershed planning area and, from the inventory, determine potential storage sites.

Implementation Date	Completion date	Lead Responsibility (Partners)
April 1, 2006	November 1, 2006	Saskatchewan Watershed Authority - Regional Operations, Weyburn Lower Souris River Watershed Board Four Creeks Watershed Advisory Committee Ducks Unlimited Canada Prairie Provinces Water Board West Souris River Conservation District

Photo courtesy Ducks Unlimited Canada

Success Measurement:

1. All water management decisions are discussed and recommendations are given by the Lower Souris River Watershed Board.
2. Watershed residents understand water management decisions.
3. Fifty percent of all drainage projects requiring approval have licenses.
4. There are fewer drainage complaints, less unwanted flooding of agricultural land, and more restored and protected wetlands.

6.9 Fish Migration and Habitat

Although the extent of fish migration and habitat is relatively unknown in the Lower Souris River Watershed, the Pipestone watershed planning area contains a good fish population located both upstream and downstream of Moosomin Reservoir.

Barriers to fish passage are any features or constructs that prevent fish movement within the water body, and can include water control dams, beaver dams, roads, man-made crossings, culverts, and sediment deposit areas.

The range of fish habitat and migration in the Antler River and Four Creeks watershed planning areas is not fully understood.

The West Souris River Conservation District has initiated a fisheries inventory review for a number of streams in their region, including the Jackson, Stony, and Graham Creeks. It is anticipated that this review will be made public once completed.

Although not directly a source water protection initiative, fish populations and fish habitat are an excellent indicator of the health of any watershed.

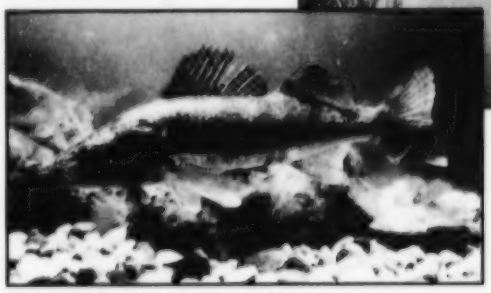
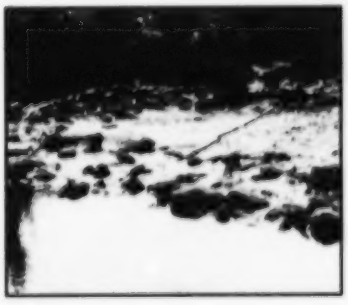


Photo courtesy Fisheries and Oceans Canada

Objective:

To increase the knowledge of fish habitat and range within the Antler River and Four Creeks watershed planning areas and improve both fish migration and habitat in the Pipestone Creek watershed planning area.



Recommendations:

- Evaluate the barriers to fish migration on Pipestone Creek and contributing major streams.
- Develop a plan to improve fish migration on Pipestone Creek.
- Determine the extent of fish habitat loss upstream of Moosomin Reservoir and determine if action is required.
- Conduct a fish habitat and migration survey to determine the extent and range of fish species within the Antler River and Four Creeks watershed planning areas.

Key Action: Within the Pipestone Creek watershed planning area: improve fish habitat by the development of rock riffle structures downstream of Moosomin Dam.

Implementation Date	Completion date	Responsibility
In progress	**April, 2007**	**Wawota Wildlife Federation** Saskatchewan Environment Saskatchewan Watershed Authority

Key Action: Within the Antler River and Four Creeks watershed planning areas: conduct a fish habitat and migration survey to determine the extent and range of fish species.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2009**	**Fisheries and Oceans Canada** Saskatchewan Environment

Key Action: Evaluate the barriers to fish migration upstream of Moosomin Reservoir on Pipestone Creek and contributing major streams.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2009**	**Fisheries and Oceans Canada** Saskatchewan Environment Lower Souris River Watershed Board

Success Measurement:

1. Fish range and habitat has been increased in the Pipestone Creek watershed planning area.
2. A fish habitat and range map has been developed for the Lower Souris River Watershed.

6.10 Water Supply for Small Communities

Small communities need to supply good, safe, quality water to residents in an economically feasible way. Concerns have been raised that the cost of providing certified quality water has been an economic struggle for many small communities. This economic challenge raises the potential risk of water contamination. Regulations requiring certified water treatment plant operators, additional testing, and upgrading of water treatment facilities have been the key barriers.

Water treatment is a key barrier in preventing the contamination of drinking water.

Objective:

To have all communities provide a safe, economical water supply.

Recommendations:

- Explore the feasibility of developing a regional water supply.
- Explore the sharing of expertise and technical equipment by communities.

Key Action: Develop a feasibility study for a rural pipeline(s) within the watershed.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2009**	**SaskWater** Cornerstone Regional Economic Development Authority Urban and Rural Municipalities Saskatchewan Watershed Authority - Basin Operations

Success Measurement:

All small communities have safe, sustainable, adequate and affordable water supplies by 2020.

6.11 Auburton Reservoir Potential Spillway Failure

The dam was constructed by the Prairie Farm Rehabilitation Administration (PFRA) in 1949 at the request of the Rural Municipality of Reciprocity No. 32. PFRA obtained permission to construct the dam from the Saskatchewan Water Rights Branch in 1957, but land control was not acquired and a water license was not issued. PFRA maintained the project between 1949 and 1969 with various minor repairs to the spillway and riparian outlet.

Auburton Reservoir is at risk of eventual failure through spillway erosion. This will result in the loss of the second largest reservoir in the Lower Souris River Watershed. An inspection and report on the cost of repairing the spillway was done in 1992, and concluded cost estimates of $250,000 to $500,000 in 1992 dollars. Unless repaired, the dam will most likely fail within the next 20 years. This reservoir provides alternate water supplies for local residents in times of drought, provides wildlife habitat and could potentially provide a local fishery.

Objective:

To determine the options for maintaining or abandoning Auburton Reservoir.

Recommendations:

- Allow the dam to fail.
- Develop a restoration plan for Auburton Reservoir.
- Determine if the Saskatchewan Watershed Authority will take over the dam.
- Determine the value of the reservoir to the landowner, locals, and municipal, provincial and federal governments.
- Coordinate efforts by local, provincial and federal governments to find a solution to ensure the dam is kept in place.

Key Action: Develop a decision options paper in conjunction with the landowner.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2008**	**Saskatchewan Watershed Authority - Regional Operations, Weyburn** Lower Souris River Watershed Board Antler River Watershed Advisory Committee Landowner

Success Measurement:

A decision on the future of Auburton Dam is reached by 2009.

6.12 Operation of Moosomin Dam

Moosomin Dam has been operated as a "run of the river" reservoir. Releases are sometimes made from the dam for downstream users, including local Saskatchewan farmers, Manitoba farmers and Manitoba communities. It is not always clear to residents in Saskatchewan and Manitoba why releases are or aren't made, or how this decision is determined. Local people in the watershed in Saskatchewan and downstream in Manitoba want to be directly involved in the decision-making process.

Photo courtesy Saskatchewan Environment

Objective:

To develop a mechanism to involve the public in the decision-making process in the operation of the dam.

Recommendations:

- Create a Public Advisory Committee of all stakeholders for the Moosomin Dam.
- Develop a written operating plan for the Moosomin Dam.

Key Action: Create a Public Advisory Committee of all stakeholders for the Moosomin Dam.

Implementation Date	Completion date	Responsibility
April 1, 2006	**November 1, 2006**	**Saskatchewan Watershed Authority - Regional Operations** Prairie Farm Rehabilitation Administration

Key Action: Develop a written operating plan for the Moosomin Dam.

Implementation Date	Completion date	Responsibility
November 1, 2006	**March 31, 2007**	**Saskatchewan Watershed Authority - Regional Operations, Weyburn** Prairie Farm Rehabilitation Administration Lower Souris River Watershed Board Pipestone Creek Watershed Advisory Committee West Souris River Conservation District Manitoba Conservation

Success Measurement:

Watershed residents who have an interest in the Moosomin Dam have input on its operation and understand how and why the dam is operated.

6.13 Water Conservation

Historical records and future predictions include scenarios for periods of time when water was and will be in shortage. The development of water storage is seen as a prudent water management practice.

Objective:

To provide for the development of water storage and wetland restoration at key locations within the watershed where surface water will be scarce during times of drought.

Recommendations:

- Determine interest in restoring the dam on Gainsborough Creek (Sec 18-8-30-W1st) to a licensable condition.
- Determine interest in a possible water storage project on Gainsborough Creek at W6-8-30-W1.
- Examine the possibility for pothole consolidation projects as an alternative to draining water off farmland and providing usable on-farm storage.
- Restore wetlands' function of storing water.
- Restore usable on-farm storage through the restoration of drained wetlands, and enhance and protect wetlands to ensure their multiple benefits in the future.

Key Action: Initiate the restoration of storage dams or wetlands at a minimum of five locations in the Four Creeks watershed planning area.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2007**	**Lower Souris River Watershed Board** Four Creeks Watershed Advisory Committee Saskatchewan Watershed Authority - Regional Operations, Weyburn Ducks Unlimited Canada Saskatchewan Environment

Success Measurement:

Additional water storage is identified and at least five water projects are completed by 2007.

7. Implementation

A key element of any plan is its implementation. Without it, the plan is no more than a list of good intentions. In the case of the Lower Souris River Watershed Source Water Protection Plan, the Watershed Advisory Committees recognize this fact and realize that there must be a concerted effort to ensure action items are followed through and acted upon. The Watershed Advisory Committees also recognize that watershed protection is a multi-jurisdictional and multi-agency activity involving local people and the support of both the provincial and federal levels of government. This support must not only be moral, but also financial.

The Watershed Advisory Committees envision the implementation and coordination of the watershed plan being conducted at the local level. Although volunteers can be effective in the short-term, they are not the answer to maintaining long-term sustainable watershed protection. The Watershed Advisory Committees are willing to consider hiring a Watershed Coordinator for plan implementation **IF** there is a financial commitment from other source water protection partners with similar interests. The Watershed Advisory Committees see this as the most cost-efficient and pragmatic way to ensure watersheds are protected now and, more importantly, into the future. Commencing and organizing a watershed community initiative can be very rewarding, but also poses challenges such as finding the right people and partners, communicating needs and results, raising funds, and staying afloat. Without this new direction, the Watershed Advisory Committees predict "more of the same old, same old". The Four Creeks and Pipestone Creek Watershed Advisory Committees have already organized themselves as non-profit organizations.

The Watershed Advisory Committees also recognize the invaluable advice and technical information provided by the Technical Committee. Based on this, the Watershed Advisory Committees recommend that the Technical Committee continue to meet at least once per year for the purpose of advising and supporting plan implementation, assessing the success of the plan, and for the continuing evolution of the plan.

Key Action: Hire a Watershed Coordinator on a three-year pilot project basis.

Implementation Date	Completion date	Responsibility
April 1, 2006	**March 31, 2009**	**Lower Souris River Watershed Board** Saskatchewan Watershed Authority Ducks Unlimited Canada

Key Action: Continue with the Lower Souris River Watershed Technical Committee and meet annually with the Watershed Advisory Committees.

Implementation Date	Completion date	Responsibility
April 1, 2006	**Indefinitely**	**Lower Souris River Watershed Board** Saskatchewan Watershed Authority Lower Souris River Watershed Technical Committee

8. Measuring Plan Success - The Yearly Report Card

The Saskatchewan Watershed Authority will continue to support integrated water management through the plan's implementation phase by committing at least one planning team member to be involved with the Watershed Advisory Committees. Consistent with the *State of the Watershed Reporting Framework*, a yearly watershed report card will be prepared by the watershed planning team to report on the progress of the action items, objectives and goals of the plan. The report card will report on the achievements, opportunities and challenges of meeting the overall vision and make any adjustments to the plan that have been recommended by the Watershed Advisory Committees.

Measurements of Successes

Successes can be categorized into three time periods:

- Short-Term (1-5 years) successes: Completion of tasks in timeframe stipulated.
- Medium-Term (5-20 years) successes: An observable change in attitudes.
- Long-Term (20+ years) successes: Realize changes in the watershed.

The intent of the *State of the Watershed Reporting Framework* is to establish a method for the consistent reporting of a standardized set of indicators combined with a rating system to assess overall source water conditions. This reporting system will allow comparisons of watershed health to be made among watersheds and within a watershed over time.

Once completed, many of the action items will be a milestone achievement. The effects of those action items may not necessarily be seen immediately. It may take decades to see a change in fish habitat or environmental change and even generations to see the changes in water quality or the change in attitude to protect source water.

In addition to the measurements of success included here, there will be other ways to measure success. These include tracking of improvements in certain indicators found in the *State of the Watershed Reporting Framework* and improvement in the Water Quality Index where reported. The *State of the Watershed Reporting Framework* is a report card based on a conceptual, but simplistic, model of a watershed that explicitly recognizes relationships between human activities (stressors), the state of the watershed (condition), impacts on the ecosystem, and associated management activities (responses). It will also reflect how we look at watersheds (structure and function) in the context of source water protection.

9. Conclusion

This Source Water Protection Plan is the start of making a difference in protecting source water in the Lower Souris River Watershed. The development of this plan has already resulted in a heightened awareness of source water protection amongst watershed residents. This plan does not ask all the questions, nor does it have all the answers, but it is a start towards local people making a bigger difference in their own watershed. This is not the end, but rather a beginning. The work has just begun. The success of this plan is dependant on watershed residents, as everyone can do his or her own part to protect source water.

Taking up the challenge is both noble and the right thing to do. If you are interested in becoming involved, contact your local Watershed Advisory Committee member or rural or urban municipality about making a difference in protecting source water. The Government of Saskatchewan, through the Saskatchewan Watershed Authority, is committed to supporting the implementation of watershed plans through programming, mentorship, and encouragement.

Appendix

Watershed Advisory Committees

Antler River Watershed Advisory Committee

Member	Organization
Warren Steeves (Chair)	R.M. of Argyle No. 1
Jim Burnett	Village of Glen Ewen
Rick Dancey	R.M. of Storthoaks No. 31
David Frecon	R.M. of Antler No. 61
Ross Madsen	R.M. of Antler No. 61
Wade McWhirter	R.M. of Reciprocity No. 32
Archie Miller	Village of Manor
Brian Miller	R.M. of Mount Pleasant No. 2
Valerie Olney	R.M. of Argyle No. 1
Edwin Rucks	R.M. of Enniskillen No. 3
Jeff Sanborn	Town of Redvers

Four Creeks Watershed Advisory Committee

Member	Organization
Ross Madsen (Chair)	R.M. of Antler No. 61
David Frecon	R.M. of Antler No. 61
George Howden	R.M. of Argyle No. 1
Jim Lorette	R.M. of Storthoaks No. 31
Lee McMillen	Saskatchewan Stock Growers Association
Bob Meredith	R.M. of Argyle No. 1
Elaine Morgan	R.M. of Storthoaks No. 31
Paul Poirer	R.M. of Storthoaks No. 31
Rick Poirer	R.M. of Antler No. 61
Dell Real	R.M. of Storthoaks No. 31
Don Taylor	Saskatchewan Association of Rural Municipalities
John Thiessen	R.M. of Maryfield No. 91
Ian Thompson	Saskatchewan Stock Growers Association

Pipestone Creek Watershed Advisory Committee

Member	Organization
John Van Eaton (Chair)	R.M. of Maryfield No. 91
Ross Allary	Ochapawace First Nation
Jack Berglund	R.M. of Wawken No. 93
Ernest Briggs	R.M. of Willowdale No. 153
Nancy Campbell	Town of Wapella
Jim Cairns	R.M. of Silverwood No. 123
Chris Davidson	Moosomin Regional Park Board
Ron Dube	R.M. of Hazelwood No. 94
Glen Ekert	Holistic Ranchers
Al Ferguson	Moosomin Regional Park Board
Robert Fournier	Saskatchewan Wildlife Federation
Hal Garrett	R.M. of Martin No. 122
Dean Godon	Moosomin Regional Park Board
Rhonda Hall	R.M. of Walpole No. 92
James Hoff	R.M. of Chester No. 125
Wesley Kemp	R.M. of Kingsley No. 124
Kevin Kish	Town of Kipling
Terry Latham	Wawota Wildlife Federation
Marshall McLeod	R.M. of Moosomin No. 121
Elmer Molnar	Village of Kennedy
Arthur Murray	Chester Conservation and Development Area Authority
Mervin Schmidt	R.M. of Elcapo No. 154
Norm Schmidt	Moosomin Cottage Owners
Terry Sheppard	Rocanville Fish and Wildlife
Rob Stolz	Saskatchewan Environment
Denise Swallow	Village of Windthorst
Angus Turpie Jr.	Moosomin Conservation and Development Area Authority

Lower Souris River Watershed Technical Committee

Member	Organization
Kent M. Barrett	Agriculture and Agri-Food Canada
Doug Brook	Ducks Unlimited Canada
Glen Campbell	West Souris River Conservation District
Sheldon Clarke	Government Relations – Community Planning
Lars DePauw	Penn West Petroleum Ltd.
Dwayne Donald	Ducks Unlimited Canada
John Fahlman	Saskatchewan Watershed Authority
Terry Hanley	Saskatchewan Watershed Authority
Lorne Klein	Saskatchewan Agriculture and Food
Brian Mathieson	Saskatchewan Industry and Resources
Allan McCutcheon	Saskatchewan Environment
Maureen McKegney-Clay	Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration
Clint Molde	Saskatchewan Watershed Authority
Bart Oegema	Saskatchewan Watershed Authority
Kevin O'Neill	Saskatchewan Watershed Authority
Kathleen Rispler	Regina Qu'Appelle Health Region
Girma Sahlu	Environment Canada
Darlene Sakires	Canadian Natural Resources Ltd.
Etienne Soulodre	Saskatchewan Watershed Authority
Phil Weiss	Manitoba Water Stewardship
Rick West	Fisheries and Oceans Canada
Brent Wilson	Saskatchewan Environment
Jim Yarotsky	Agriculture and Agri-Food Canada

Lower Souris River Watershed Planning Team

Member	Organization
Jeff Olson	Saskatchewan Watershed Authority
Collin McGuire	Saskatchewan Watershed Authority

Lower
Souris River
Watershed

Background Report Lower Souris River Watershed

Executive Summary

The purpose of the Background Report is to provide information on the physical, social and economical characteristics of the Lower Souris River Watershed and assist in the formulation of a Watershed Management Plan. This Plan will identify threats to source waters and provide strategies for the Lower Souris River Watershed to address these threats.

The management and protection of water resources for the benefit of Saskatchewan residents is best served when stakeholders work together and commit to actions that support a common goal. Watershed planning is an ongoing process established by open communication between stakeholders conducted at round-table discussions within various communities. The planning process normally takes between two to three years, depending on watershed complexity. The Plan will focus on source water protection and contain information such as the Background Report of the watershed, analysis of issues and perceived threats, commitment to action, timelines and responsibilities, a measure of results and an evaluation of effort.

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1.0 Introduction

Sound management of watersheds and aquifers - units that envelop entire water systems- begins with planning mechanisms which lead to effective water management. Development of a Background Report for everyone to have a collective understanding of the watershed is the start of this planning process.

This Background Report provides basic information to the local Watershed Advisory Committees (WACs), Technical Committee's (TCs) and the general public about their watershed. Among the information detailed in this report is population and demographics, economic activities and land use, climate, physical/topographic characteristics including soils, surface and ground water availability, water allocations, trends in water use and wastewater disposal and treatment. Real or perceived threats to source water are also presented. Information about inter-provincial water management agreements, ecosystem health, sound wetland and riparian management, and wildlife biodiversity is included as an introduction to the watershed.

The Background Report will be a living document subject to adjustment and additions when new relevant information is brought forward. The Background Report will provide the most contemporary information and scientific knowledge available for the WAC to make informed, scientifically-based decisions to protect both quality and quantity of source water in the development of the watershed plan.

1.1 Source Water and Human Health

Clean water is essential to life. Our health and well-being depend on it. The best way to ensure drinking water supplies are kept clean, safe and reliable is to take a preventive risk management approach. This means understanding each water supply from its beginning in nature to where it reaches the consumer. This understanding—about the water's characteristics, the ways it could become contaminated, and the type of treatment it needs—comes from collecting and studying data.

The drinking water supply can be broken down into three parts: the source water, the drinking water treatment system, and the distribution system which carries the treated water to homes, businesses, schools, and other buildings. As the drinking water travels on its journey to the consumer, it could become contaminated in many ways, some known, others predictable. The multi-barrier approach to managing drinking water supplies is one preventive risk management approach that identifies all these known and potential hazards and makes sure barriers are in place to reduce or eliminate the risk of contamination.

Canadian drinking water supplies are largely free of the disease-causing organisms found in the water supplies of many developing countries. Recently, however, there has been increasing concern over the presence in drinking water of parasites such as Giardia and Cryptosporidium, which are resistant to common disinfection practices. There has also been growing public awareness and

increasing alarm over the presence of a wide range of natural and man-made chemical contaminants in drinking water.

Of all contaminants in drinking water, human and/or animal feces present the greatest danger to public health. Bacteriological testing provides a sensitive means for the detection and control of such pollution. Although modern microbiological techniques have made the detection of pathogenic bacteria, viruses and protozoa in sewage and sewage effluents possible, it is not practical to attempt to routinely isolate them from drinking water. It should be emphasized that no bacteriological analysis can replace a complete knowledge of the quality of the water at the source of supply, during treatment and throughout the distribution system. Contamination is often intermittent and may not be revealed by the examination of a single sample.

Although ground water has historically been thought to be free of microbial contamination, recent research indicates that some ground waters are a source of waterborne disease. Most cases of waterborne disease are characterized by symptoms such as diarrhea or vomiting that rarely require medical treatment in healthy individuals. However, these same symptoms are much more serious and can be fatal for young children, the elderly, and persons with compromised immune systems. In addition, research indicates that some viral pathogens found in ground water are linked to long term health effects such as adult onset diabetes and myocarditis, an inflammation of the heart muscle.

Contaminants in drinking water may also come from a variety of sources; these include naturally-occurring chemicals (such as arsenic and asbestos), natural and industrial radioactive materials (such as radon), and synthetic chemicals from industrial effluents and emissions, and agricultural practices residue. Substances such as lead and copper may leach from the drinking water materials used in the water distribution system itself.

Testing and treating of surface water sources and of ground water sources, which are under direct influence of surface water, are much more in-depth than testing and treating of ground water sources alone. A large number of organic and inorganic chemicals, such as trihalomethanes, haloacids, bromate and chlorate, are found in disinfected drinking water as a result of reactions between disinfectants and chemical precursors in the source water. Many of these disinfection by-products have been shown to cause adverse health effects at high doses in experimental animals, and epidemiology studies have suggested potential risks of cancer and adverse reproductive outcomes in human populations.

Below are examples of source water contaminants and their link to human health problems.

Lead - The Environmental Protection Agency (EPA) says that lead in drinking water can cause serious health problems. At low levels, reduced birth weight and premature birth, delayed mental and physical development, and impaired mental abilities in children in general, may result. At high levels of exposure, anemia, kidney damage, and mental retardation can occur.

Radon - Radon is a naturally occurring radioactive gas that has no taste, odor, or color. Waterborne radon released into the air from showers, washing machines, etc. Can be inhaled and increase the risk of lung cancer. There also is accumulating evidence of a relationship between the ingestion of radon in drinking water and increased risk of stomach cancer.

Cysts - Protozoan parasites, such as Cryptosporidium oocysts and Giardia lamblia cysts in drinking water, can cause vomiting, diarrhea, an other flulike symptoms that are longer-lasting and more debilitating than most cases of flu.

Pesticides and Herbicides - Many agricultural chemicals like atrazine and alachlor have found their way into groundwater sources. Many pesticides are toxic and are associated with a variety of health problems. Approximately 50,000 different pesticide products are used in Canada, composed of over 600 active ingredients. Although the acute health effects of ingesting large amounts of a pesticide can readily be measured, the chronic effects of long-term exposure to low levels are much harder to define.

Arsenic - According to a 1999 study by the National Academy of Sciences, arsenic in drinking water causes bladder, lung and skin cancer, and may cause kidney and liver cancer. The study also found that arsenic harms the central and peripheral nervous systems, as well as heart and blood vessels, and causes serious skin problems. It also may cause birth defects and reproductive problems.

Industrial Chemicals - Though necessary in manufacturing, many industrial chemicals, if ingested, may cause increased risk of cancer and others illnesses. Some of the industrial chemicals that now threaten the purity and safeness of drinking water include polychlorinated biphenyls (PCBs), polynuclear aromatics (PNAs), and volatile organic chemicals (VOCs), such as TCE, benzene, and carbon tetrachloride.

THMs and Chlorine - Many municipal water systems use chlorine to eliminate bacteria, but recent studies show that chlorine can react with organic material in water to form chemicals called Trihalomethanes (THMs). One of these THMs is chloroform, a suspected cancer-causing agent.

Other Particulate Contaminants - Small fibers of asbestos, dirt, and other particles can often be found in drinking water. ·

Continuing research is required to obtain sufficient understanding of the human health risks posed by these chemical and microbiological contaminants, and to develop a strong scientific basis for setting new drinking water standards that may be needed to protect public health.

It is in everyone's best interest to ensure that the natural source water is protected from man-made contamination. It also cannot be emphasized enough that routine testing of water to determine quality of source water and then instituting the necessary water treatment is basic human health precautionary protection. Without all barriers in place the consequences to individual human health can be severe.

2.0 Watershed Characteristics

2.1 Physical Characteristics

Physical Setting

Courtesy: Saskatchewan Watershed Authority

Watershed: a region that drains into a particular body of water, such as a river, pond, or lake.

The Lower Souris River Watershed is located in the south-eastern part of Saskatchewan, bounded to the east by the province of Manitoba and to the south by the state of North Dakota (Figure 1). Ecologically, the Lower Souris River Watershed is located in an area known as Aspen Parkland. Undisturbed, the Aspen Parkland ecoregion is a mix of aspen groves and fescue grasslands and represents the zone of transition between open grasslands and continuous forest. Agriculture use has drastically altered this ecoregion, with 80 percent of the landscape now cropland.

The ecoregion of Saskatchewan framework describes six landscape areas, which overlap with the Lower Souris River Watershed: Moose Mountain Upland, Moose Mountain, Kipling Plain, Melville Plain, Gainsborough Plain and Oak Lake Plain (Figure 2). Two small portions of the Moose Mountain Upland exist in the north-west area of the watershed.

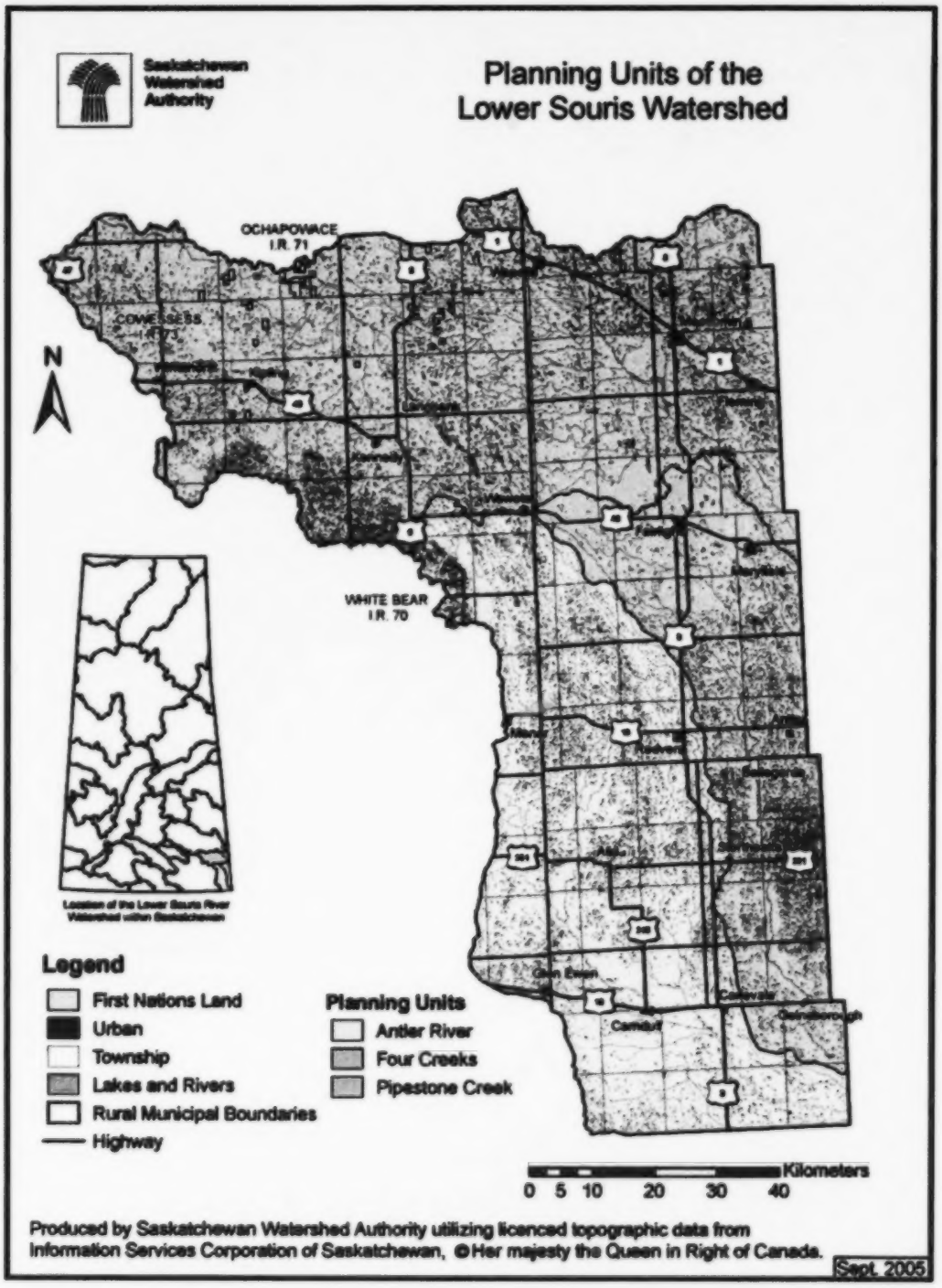


Figure 1: Planning Units of the Lower Souris River Watershed

The landscape is described as "knob and kettle" with numerous bowl-shaped depressions that form wetlands and small lakes. The elevation in this area is somewhere between 600 and 730 metres. On the western edge of the watershed, the Moose Mountain area extends the "knob and kettle" landscape and is comprised of continuous forested land. The elevation rises from 730 to 800 metres. The northwest corner of the watershed is referred to as the Kipling Plain. The landscape consists of mounds, ridges and other distinct deposits of clay, silt, sand, gravel and boulders. Elevation rises from 600 metres in the lower plain to 670 metres, with isolated areas at 700 metres. The Melville Plain is a level landscape in the northeast part of the watershed. The landscape is similar to the Kipling Plain except for its elevation, which slopes from 550 to 520 metres. The most predominant landscape in the watershed is the Gainsborough Plain. It is a level area with a gently rolling topography and numerous small kettles. The elevation drops from the Moose Mountains, 730 metres, to 480 metres at the Manitoba border. The Oak Lake Plain is a level area of land that follows the Antler River across the south-eastern portion of the watershed. Elevation here drops from 580 to 490 metres. Figure 3 shows the changes in elevation for the Lower Souris River Watershed.

The Land Forms

The soils and vegetation are largely influenced by the post-glacial history of the Lower Souris River Watershed. The last glacier advanced across this area about 20,000 years ago and retreated from the area approximately 14,000 to 15,500 years ago. All the surface land forms in the Lower Souris River Watershed, with exception of those in the bottom of drainage channels, were laid down as a result of glaciation.

There were four significant phases in the glacial retreat in the Lower Souris River Watershed. In the first phase, the Moose Mountain Creek channel drained an area between two ice lobes to the south and west of the area. The meltwater flowed southward into the Souris River. During phase two, the meltwater from the ice was trapped by the high ground to the south and was forced to run eastward. The result was the formation of the sidehill Hillesden and Pipestone channels. As the ice retreated from phase one to four, the glaciers deposited glacial till and where local glacial lakes formed, silts and clays were deposited. During phase three, ice retreated somewhat with further development of the Pipestone channel. In the last stage, approximately 14,000 years ago, the ice retreated to an area north of the Qu'Appelle River valley. After the retreat, coulees developed along the Pipestone Creek's south side and along the uplands of the Moose Mountains. This activity moved sediments into channel bottoms resulting in the formation of lakes at the bottom of the channels or the reversal of flows from their original flows during glacier melting.

Soils

Soils form the basic foundation for vegetative and hydrological processes. An understanding of the properties of soils is important for source water protection.

Dominant soils in the Lower Souris River Watershed are Oxbow loams black chernozemic. These are black grassland soils in the black soils zone (precipitation), and have a loamy texture (Figure 4). Other important soils are the Whitewood soils – gleysolic soils (wooded soils) found in the Moose Mountains and north-facing slopes of Pipestone

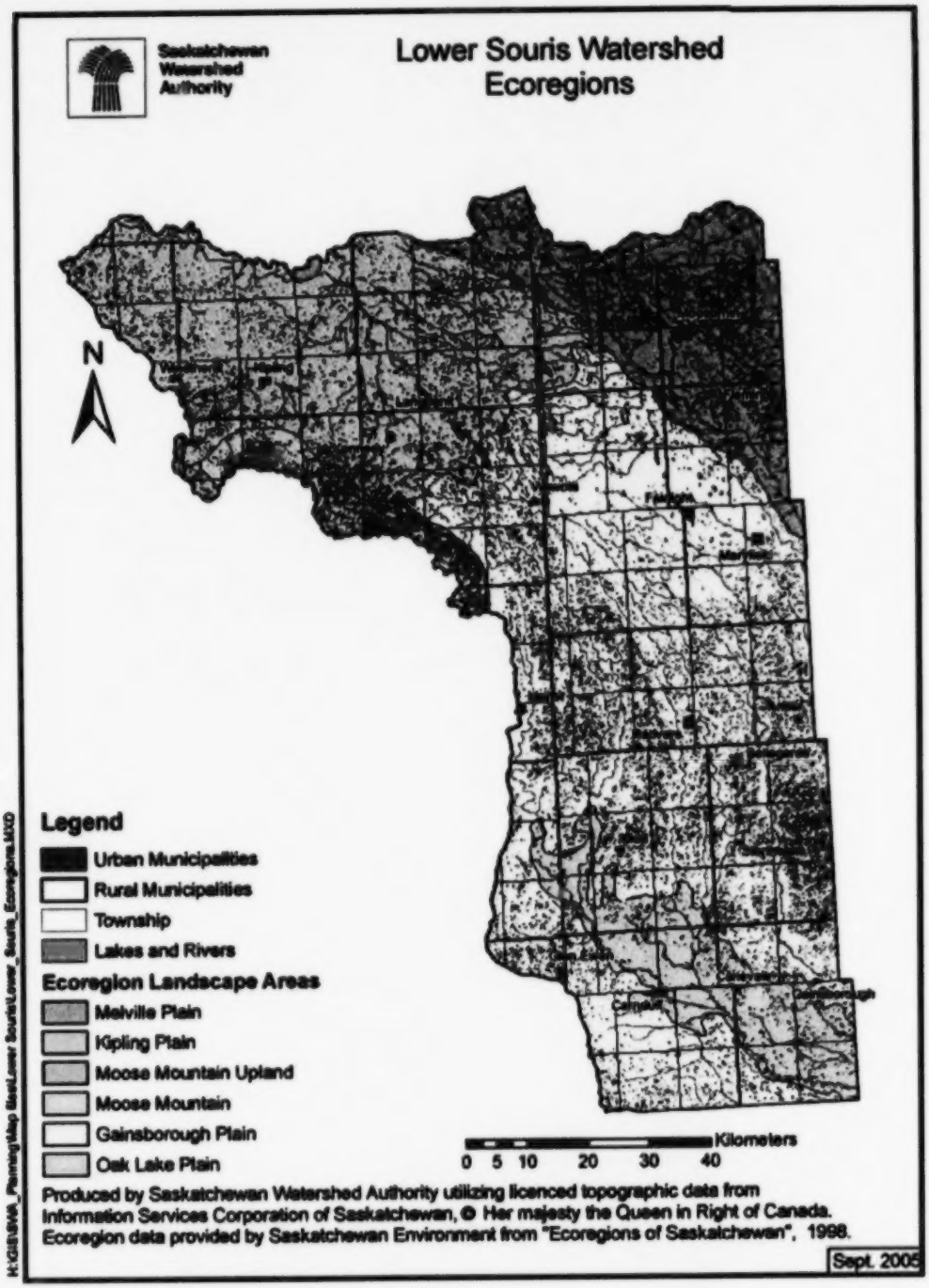


Figure 2: Ecoregions

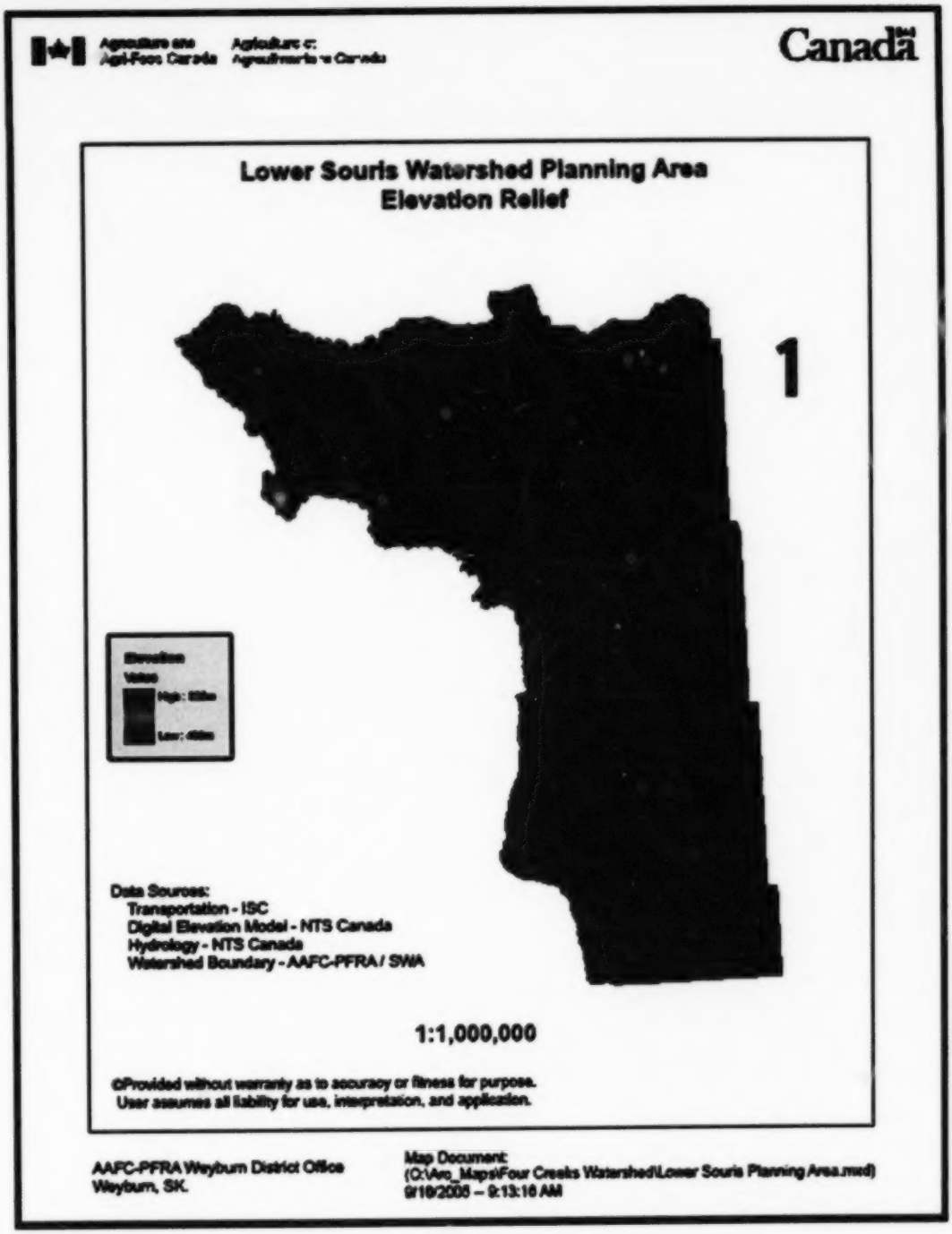


Figure 3: Digital Elevation Model

Creek and the Windthorst soils, which are loamy soils with pockets of lighter soil texture. In Creek - and the Windthorst soils, which are loamy soils with pockets of lighter soil texture. In areas of the watershed where the landscape is rolling and hummocky, the soils can be quite varied. Lighter texture soils occur in association with river channels. In the Antler River Planning Unit, a large amount of lighter soils are associated with the areas surrounding the river.

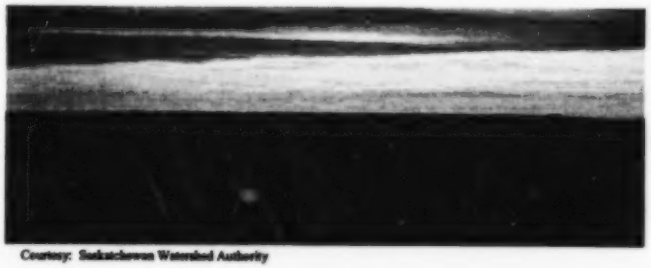
Soils may impact source water through wind and water erosion. Erosion rates are affected by climate, soil texture, and cover. Soil erosion estimates are available on a 1:100,000 scale map and, without taking vegetation cover into consideration, indicate that little of the watershed is comprised of erosion prone soils.

Vegetation

Vegetation in the Lower Souris River Watershed is typical of the Aspen Parkland ecoregion. Native vegetation has been drastically altered since European settlement. Perennial cover presently accounts for less then 20 percent of the landscape (Figure 5).

Areas of native prairie vegetation are generally limited to river valleys, school sections and areas of extremely poor soils. Where upland native prairie exists, lack of fire has resulted in aspen and shrub encroachment in what historically would have been an open prairie landscape. Upland native prairie area has been altered by the invasion of exotic species, especially Kentucky Blue Grass and Smooth Brome. It is unclear whether this invasion is the result of the alterations to the fire, grazing and drought regimes or if the landscape is vulnerable to invasion.

Other unique vegetative features of the area include the Moose Mountain's near continuous aspen forest, which serve as the headwaters for Pipestone Creek and Antler River. Riparian vegetation along the larger creeks is dominated by Saskatoon and Chokecherry shrubs. Riparian forests can include Manitoba maple and burr oak. The Lower Souris River Watershed also has unique eastern species of plants like the big blue stem, prairie dropseed, and fern.



Courtesy: Saskatchewan Watershed Authority

Fish and Wildlife

The Lower Souris River Watershed is an important area for a variety of fish and wildlife species. In the creeks and streams, eight species of fish are recorded, including the walleye, northern pike and perch. The most common amphibians and reptiles are the leopard frog, tiger salamander and painted turtle. The smooth green and red belly snakes are also located in the watershed. There are over 320 species of birds that visit or take residence in the watershed. Most common are the ducks, Canada goose, sharp-tail grouse, western meadowlark, yellow warbler, crow, red-tail hawk and great horned owl. Common animals include the muskrat, badger, white-tail deer and ground squirrel.

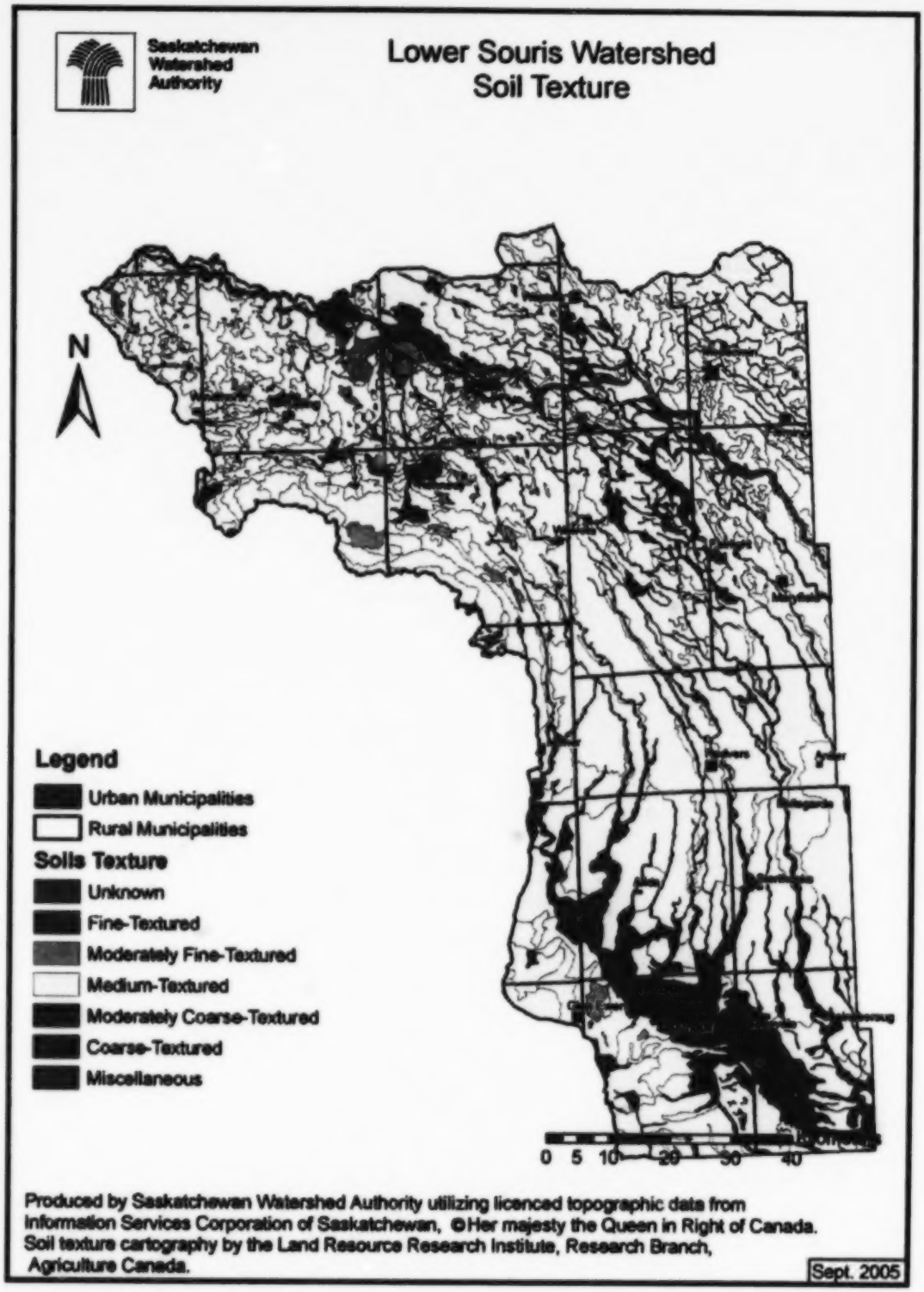


Figure 4: Surface Texture

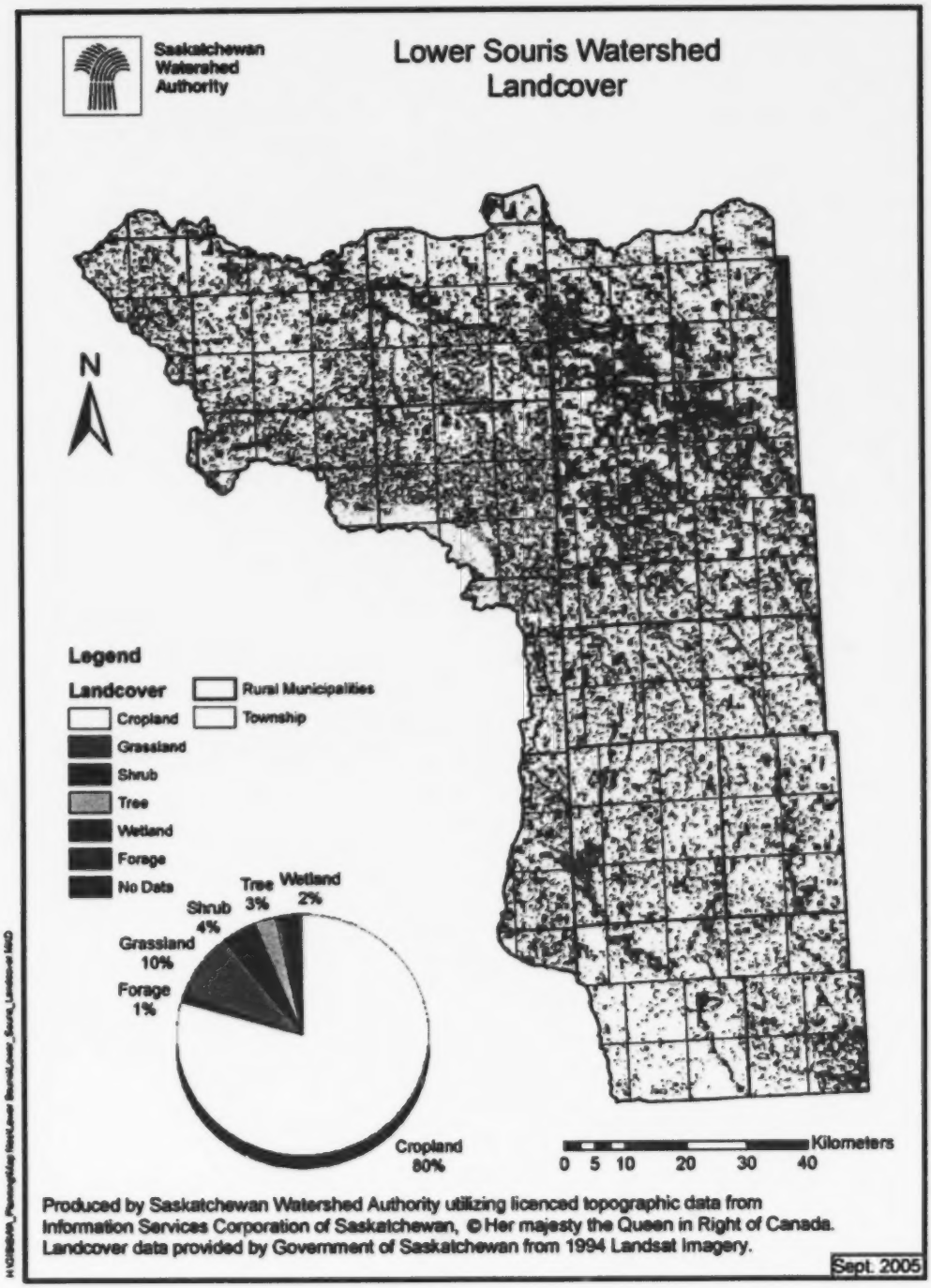


Figure 5: Lower Souris River Watershed Landcover

Demographics

Based on the 2001 Saskatchewan Bureau of Statistics data, the population of the Lower Souris River Watershed is approximately 14,300. The rural population accounts for 37 percent of the population while the remaining 63 percent of the population live in the watershed's communities (Figure 6).

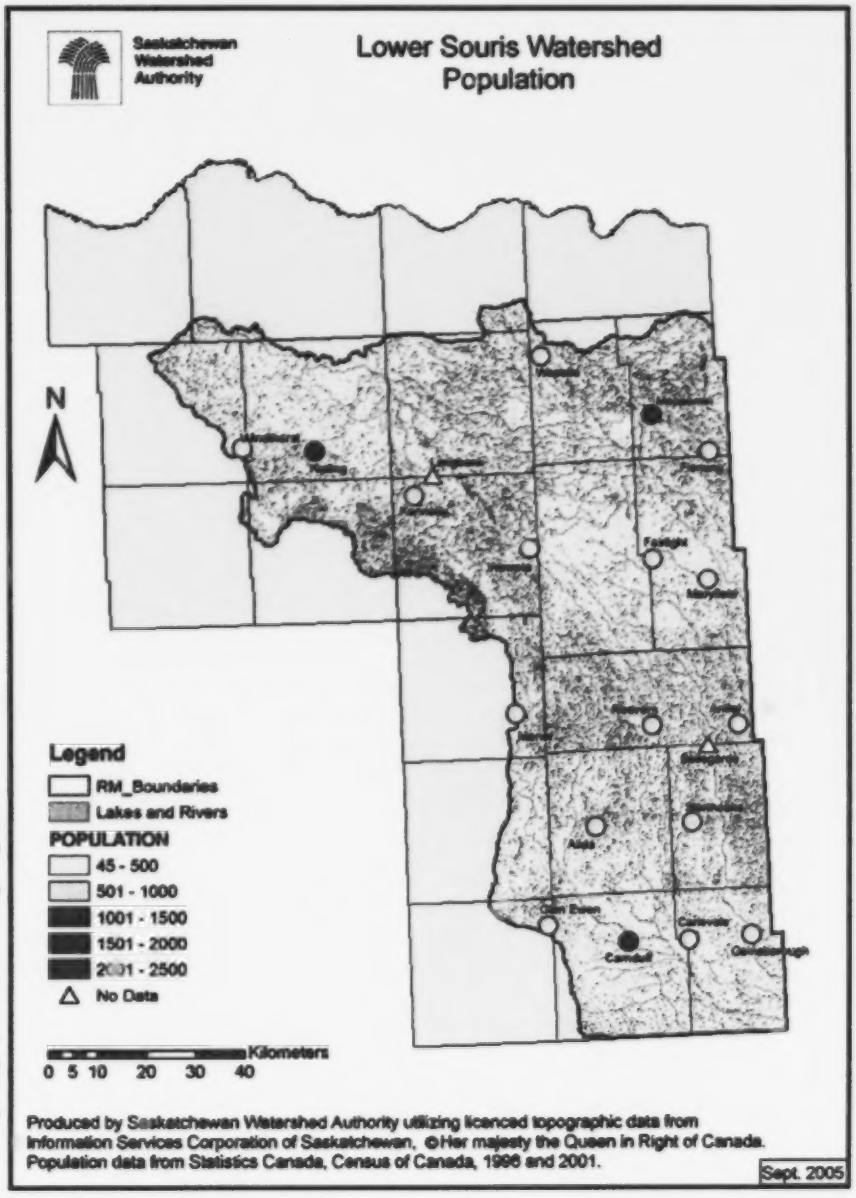

Saskatchewan Watershed Authority
Lower Souris Watershed Population
N
Legend
RM_Boundaries
Lakes and Rivers
POPULATION
45 - 500
501 - 1000
1001 - 1500
1501 - 2000
2001 - 2500
No Data
Kilometers
0 5 10 20 30 40
Produced by Saskatchewan Watershed Authority utilizing licenced topographic data from Information Services Corporation of Saskatchewan, ©Her majesty the Queen in Right of Canada.
Population data from Statistics Canada, Census of Canada, 1996 and 2001.
Sept. 2005

Figure 6: Population

3.0 Economic Activities
3.1 Agriculture

The agricultural area in the Lower Souris River Watershed is typical of the Aspen Parkland. Acres are dominated by annual cropping with a component of livestock, primarily in the form of cow-calf and some small feeding operations.

Significant opportunities for investment and development have been identified in the watershed area. They include both primary production and processing in the areas of beef, forage, pulse and organic production. Currently, no secondary processing for crops and or livestock exists in the watershed area.

Courtesy: Saskatchewan Watershed Authority

Beef: Cow-Calf

The Lower Souris River Watershed has long been a mixed farming area with a strong cattle component. Low grain prices, various forage seeding programs, previously strong cattle prices and an influx of ranchers from western Saskatchewan and Alberta have been responsible for some growth and consolidation of the cow herd. The southeast region has historically had a high percentage of the provincial cow herd and according to 1996 Statistics Canada data, there are approximately 500 farms reporting livestock. Figure 7 (Statistics Canada, 2001) reflects 10 of the Rural Municipalities with fairly significant numbers of cattle. Rural Municipalities # 92 and # 93 show the highest density with cattle numbers averaging 15,000 – 19,000 head per Rural Municipality. Cow herd numbers vary greatly, ranging from 55 – 400 cows with some interest in expanding those cow herd numbers by up to 20 percent. Some of this increase might be taken up with some larger community cow herds and some First Nations cow herds. Water supply does not seem to be a limiting factor related to expansion, although there may be some issues related to water quality that prove challenging.

Statistic: Cattle graze along an estimated 25,000 miles of creek in agricultural Saskatchewan.

Beef: Feedlots

The feeding industry has accelerated since the late 1990's as a result of the Crow Rate collapsing. The existence of three large commercial feed mills and two GSP (grain screening pellet) mills, which may be expanding, offer excellent access to feed. As feeders have gained experience they have grown in size. There are approximately six approved cattle feedlots in the watershed that contain over 300 animal units each.

The long term effects of the Bovine Spongiform Encephalopathy (BSE) crisis are unknown but will likely affect the feeding industry significantly. Nevertheless, there appears to be growing interest in beef expansion by independent, private and community-based groups. Expansion plans optimistically projected a doubling of feeding capacity for the watershed area. While these projections may have been overly optimistic, a strong supply of calves, available land, labour, feed and low production costs indicate that the area is ready for expansion.

Lower Souris River Watershed
2001 Total Cattle and Calves

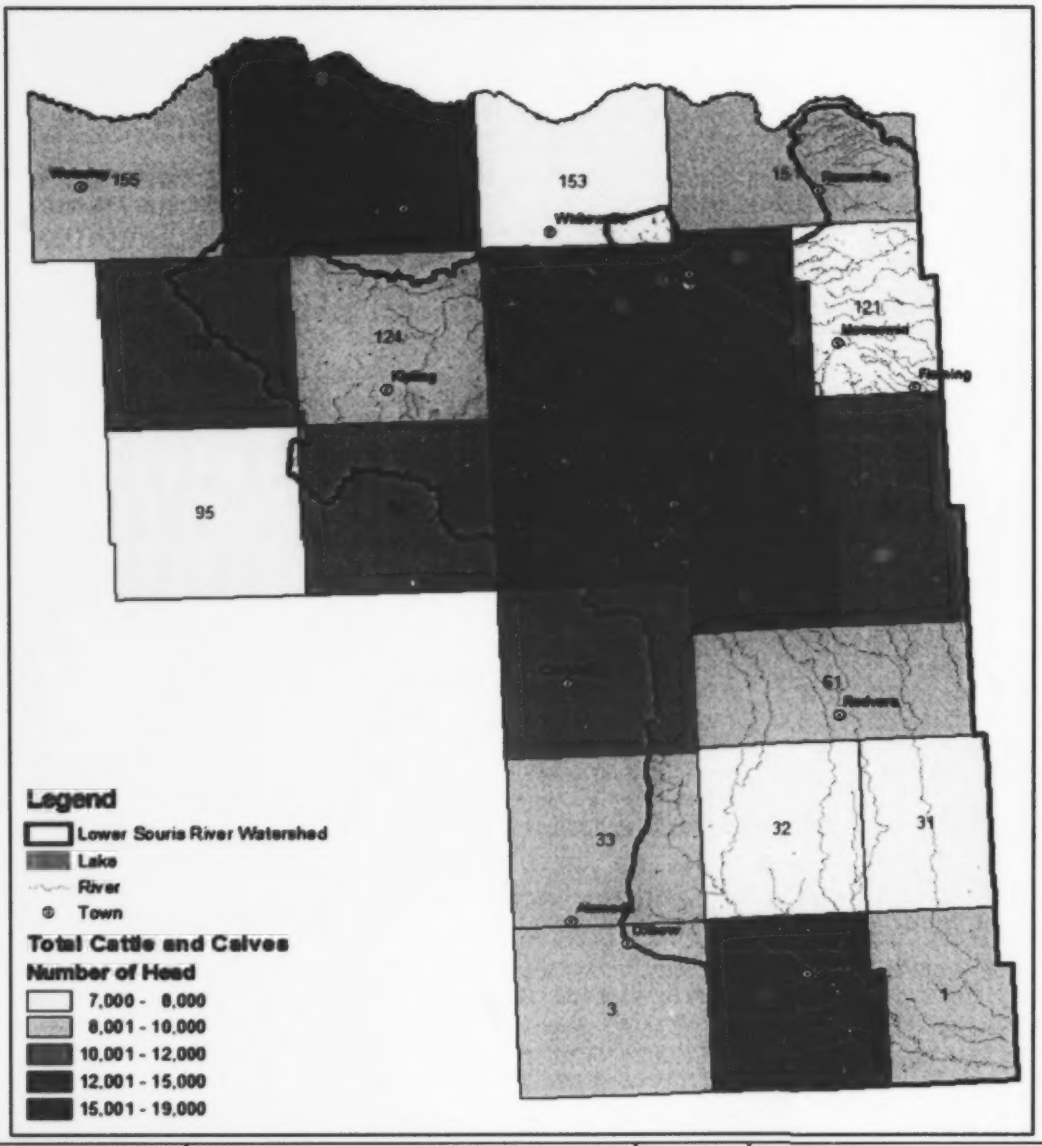


Figure 7: 2001 Total Cattle and Calves

Dairy

There are two dairies located in the watershed in Rural Municipality # 124 (Figure 8).

Forages

Native and tame pastures are prevalent throughout the watershed, although larger acreages occur in the northern portion of the watershed (Figures 11 & 12). Land class and environmental concerns have resulted in the conversion of marginal land to permanent cover. Provincial and Federal incentive programs have encouraged the establishment of perennial forage acres in the watershed. In order to support livestock growth, forage acreages will have to increase. In a survey of 45 range health assessments, the average range health was rated as 49 percent, indicating an unhealthy state (Etienne Soulodre, 2004: Appendix V). Good management of existing and new forage acres is essential to the sustainability of forage resources. Healthy rangelands conserve soil moisture, aid in filtration, prevent erosion, provide wildlife habitat, and can better sustain drought.

Hogs

The Lower Souris River Watershed area has not traditionally supported hog production. However, the watershed's proximity to Manitoba and Brandon's slaughter and packing industry provide some opportunities for expansion. Figure 9 shows there are approximately ten hog operations presently approved by Saskatchewan Agriculture and Food in the watershed (See Intensive Hog Operations - *Note:* Hog operations depicted on Figure 9 may be approved but not yet operating or built.) There has been some interest in building a farrowing facility and feeder barns in the region. The proximity to the Maple Leaf Processing Plant in Brandon would support the increased production in the hog industry. Feed grains are available in the area and offer alternative markets for cereals which are subject to high freight rates. A number of Rural Municipalities are investigating the opportunities for hog and beef production. In 2004 a local task force was struck by the Rural Municipality of Moosomin to explore the opportunities for hog development. In 2005 the Rural Municipality declined an application for a 6,000 head feeder operation. The Rural Municipality of Walpole # 92 was also approached with a view to develop five new hog finishing facilities, with a total of 30,000 finishing spaces. Discussions are underway as of August 2005. There is also good potential for the development of an additional 10,000 – 20,000 finishing spaces in the Rural Municipality of Willowdale # 153.

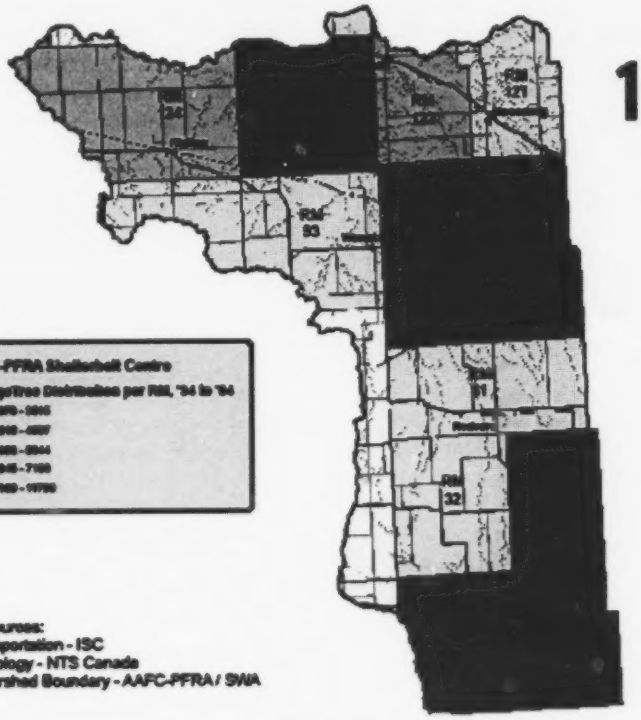
Regulations

The Agriculture Operations Act, administered by Saskatchewan Agriculture and Food defines an Intensive Livestock Operation (ILO) as the confining of prescribed animals where the space per animal unit is less than 370 square metres. An approval from Saskatchewan Agriculture and Food is required for any Intensive Livestock Operation, which has an earthen manure storage lagoon; involves the rearing, confining or feeding of 300 or more animal units; or confines more than 20 animal units (but less than 300 animal units) for more than 10 days in any 30-day period within 300 metres of any surface water or 30 metres of a domestic water well not controlled by the operator. An animal unit is a means to compare different livestock operations based on animal weight or nutrient output. For new Intensive Livestock Operations, the operator is required to submit plans for waste storage and for waste management. Approval is issued if these plans provide adequate protection for surface and ground water resources and after the proposal is reviewed by various government agencies. If significant concerns are raised during the review process, the Intensive Livestock Operation may be required to provide additional plans to mitigate risks and/or change its site location. If sensitivities are identified through the review process, environmental monitoring could be a requirement of the approval.

Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

Canada

Lower Souris Watershed Planning Area
AAFC-PFRA Shelterbelt Centre - Average Tree Distribution



Data Sources:
Transportation - ISC
Hydrology - NTS Canada
Watershed Boundary - AAFC-PFRA / SWA

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AAFC-PFRA Weyburn District Office
Weyburn, SK.

Map Document:
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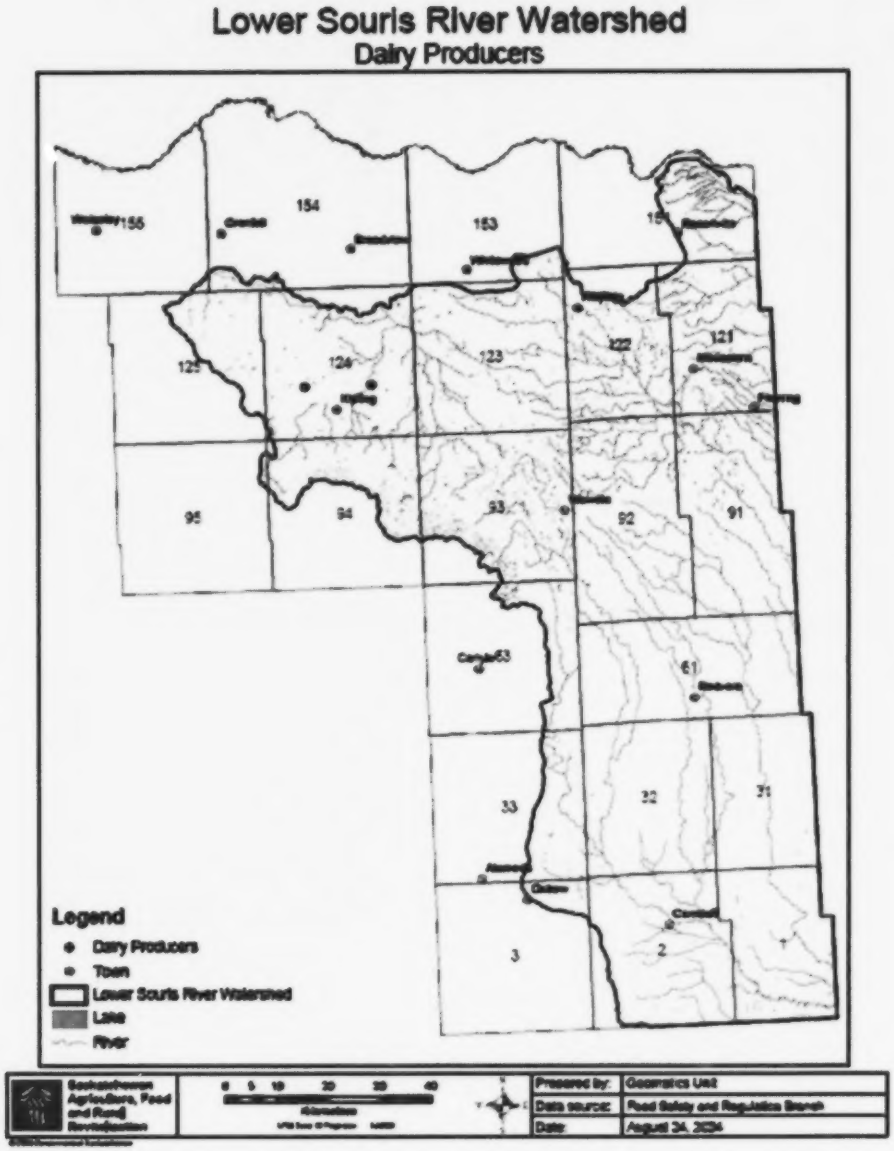


Figure 8: Diary Producers

Lower Souris River Watershed
2001 Total Pigs

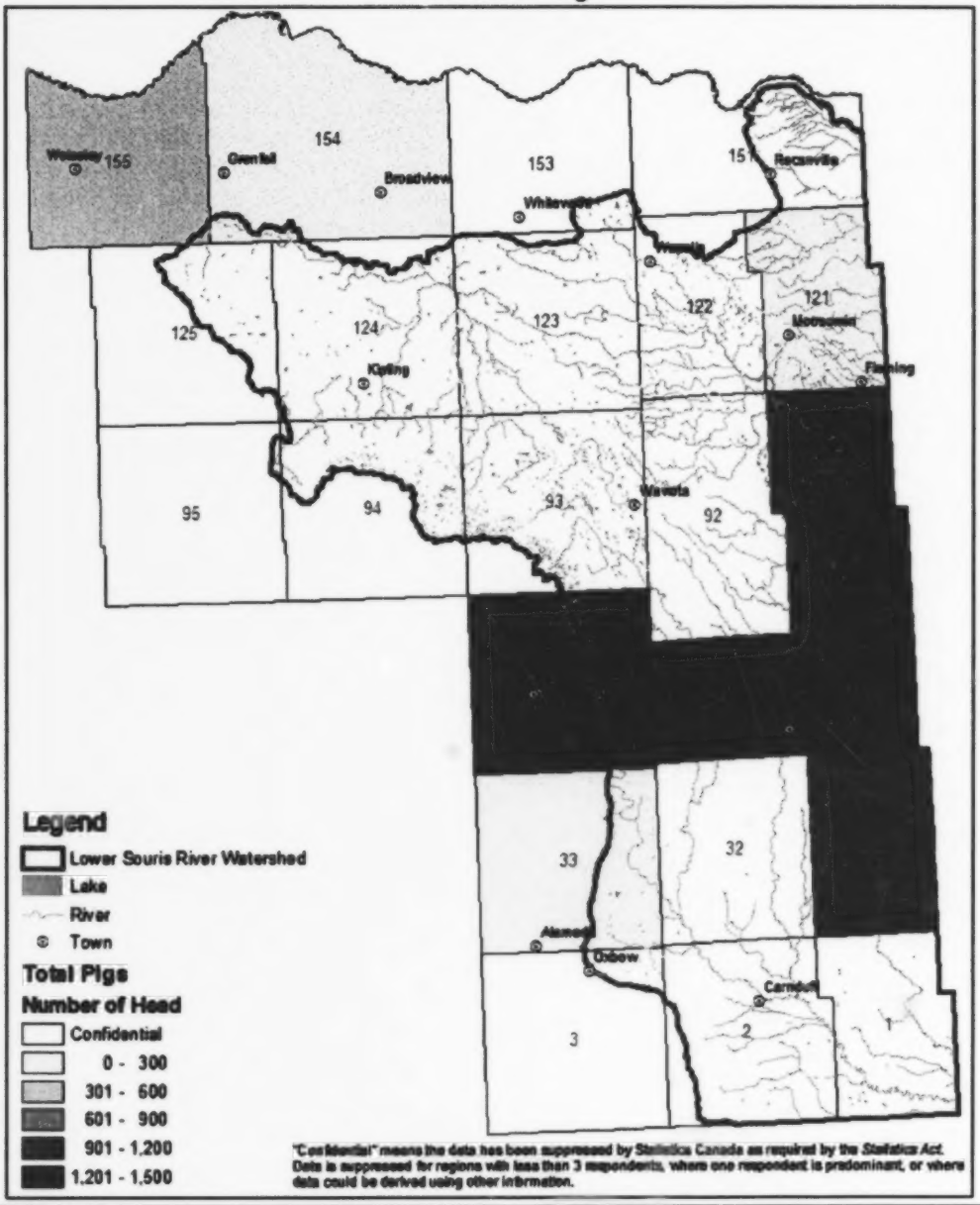
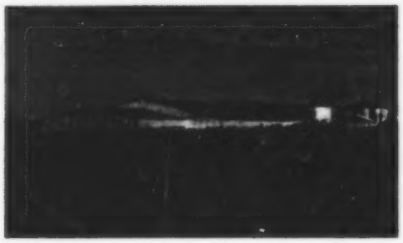


Figure 9: 2001 Total Pigs

Potential Impacts from Livestock Operations (Intensive and Extensive)

Livestock operations that confine animals temporarily or permanently need to be managed in a way that minimizes the impact to soil, water and air. Livestock operations may not be ideally located or managed, and issues related to soil nutrient loading, surface water, groundwater, riparian health and odour may exist regardless of size. Producers need to be aware of their potential impact on surface and ground water and the importance of evaluating their sites and taking any necessary corrective actions to protect soil, water, and air. Producers across Saskatchewan are applying practical solutions to address these issues. These solutions include:

- Good site selection;
- Reducing the concentration of animals;
- Water development;
- Runoff and erosion control;
- Buffer strips;
- Manure management planning;
- Effective manure application and timing;
- Controlled access; and
- Relocation of facilities.



Courtesy: Four Creeks Watershed Inc.

Data on the kilometres of stream course and the survey data from two flights were combined with 1996 Agricultural Census data to estimate the number of cattle wintering sites in the province that might trigger the *Agricultural Operations Act* (AOA). Of approximately 21,000 cattle operations in Saskatchewan, there are an estimated 11,000 that could require approval under the Act, with the largest percentage occurring in the grassland regions of the province. This number is at best preliminary as it is based on a survey only 300 kilometres along major water courses.

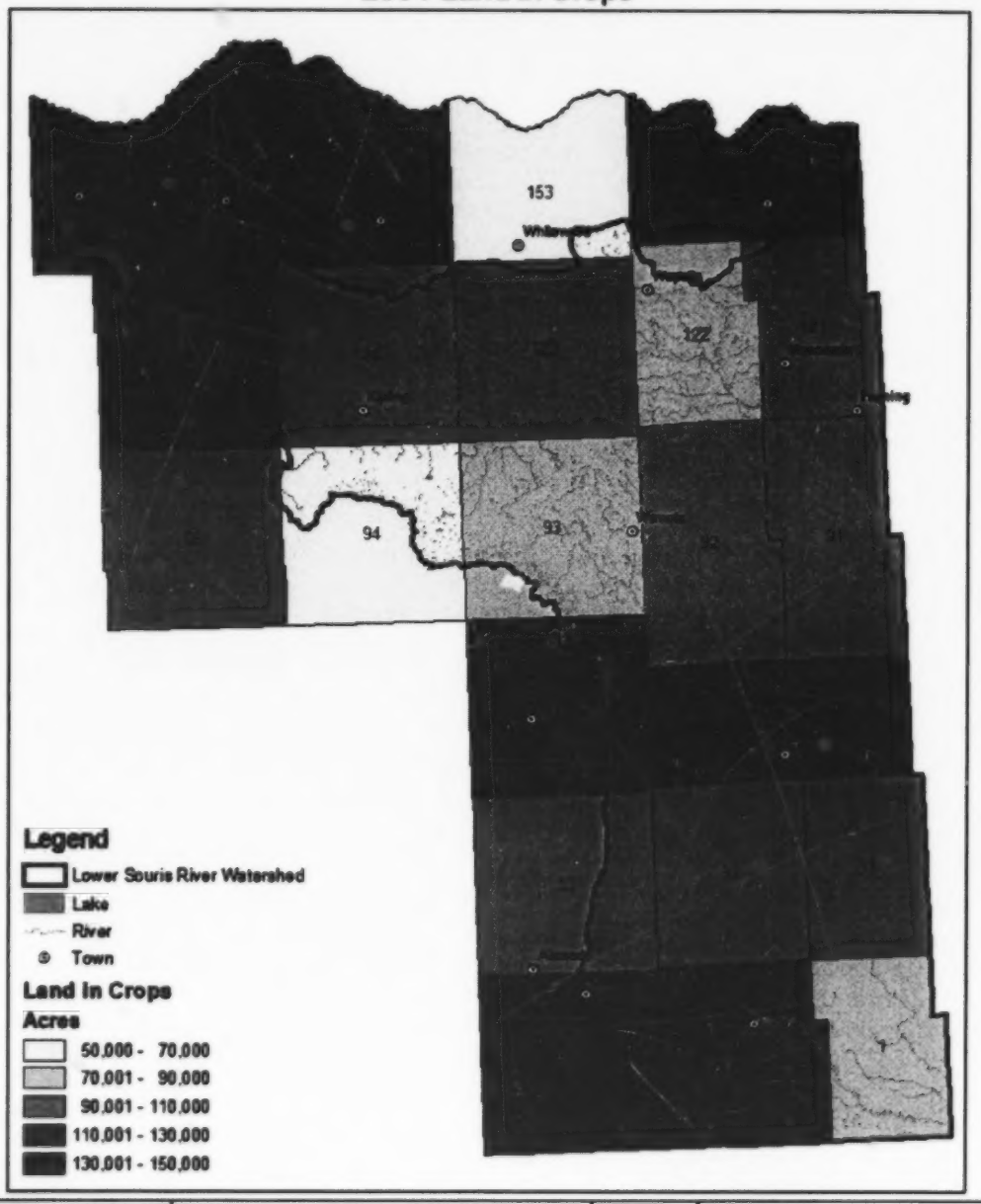
The *Agricultural Operations Act* is administered by staff of Saskatchewan Agriculture and Food located in Rural Services Centres in Saskatoon, Weyburn and Yorkton. The approach to delivering the *Act* has been proactive and the policy is to work with producers to address on-site issues and apply the principles of good site selection to new and expanding operations. Saskatchewan Agriculture and Food specialists with the Livestock Development Branch are also available to assist producers with manure management planning, site selection and management and production options. Saskatchewan Agriculture and Food has a self evaluation (Appendix IV) that can assist livestock and poultry producers to determine if an approval is required. Producers who require plan approval for their operations are required to submit plans outlining how they will store manure, how the manure nutrients will be utilized and how they will handle and dispose of dead animals.

Crops

Within the Lower Souris River Watershed, the crop varieties have evolved to include high-value crops, low volume crops, crops with value-added or value-chain potential, traditional cereal grains (which are seeking new markets) and forage crops/grass.

Overall, wheat acres have decreased and canola, pea, and sunflower acres have increased. The largest change in crop production has been the dramatic increase of forage acres. This change was being driven by lower annual crop commodity prices and more buoyant cattle

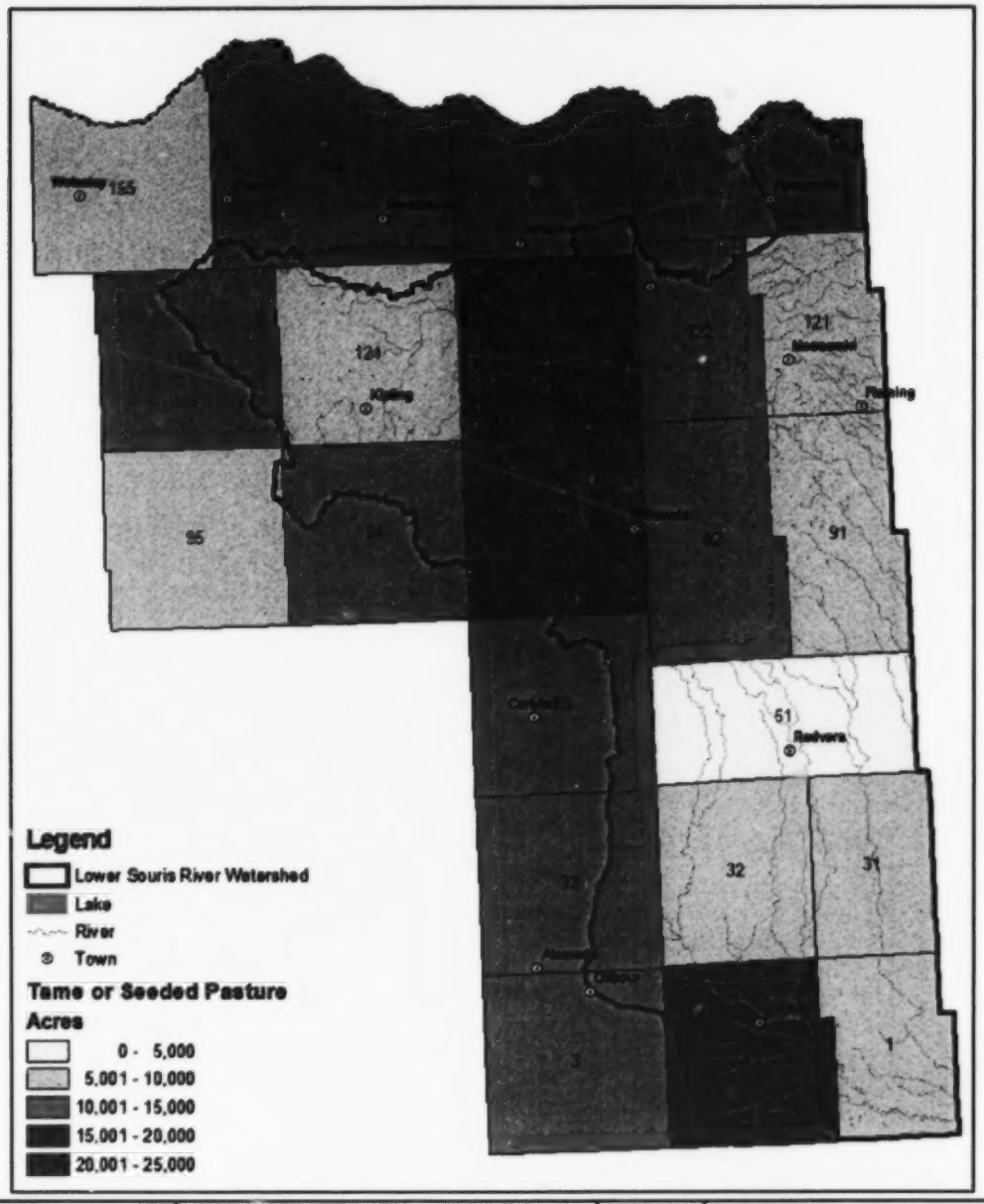
Lower Souris River Watershed
2001 Land in Crops



Prepared by:	Geomatics Unit
Data source:	Statistics Canada, 2001 Census of Agriculture
Date:	March 25, 2004

Figure 10: 2001 Land in Crops

Lower Souris River Watershed
2001 Tame or Seeded Pasture



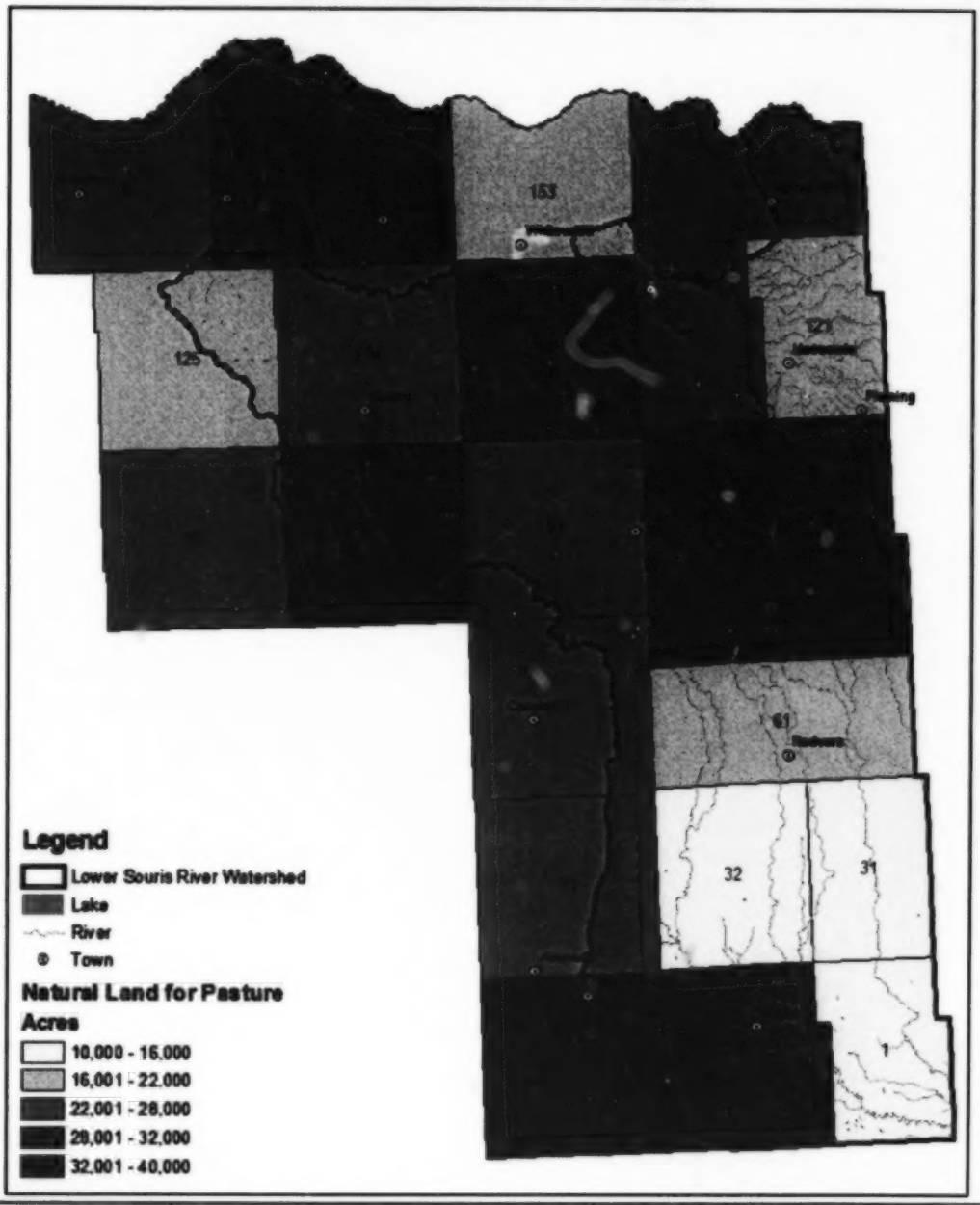
Saskatchewan Agriculture, Food and Rural Revitalization

0 5 10 20 30 40
Kilometers

Prepared by:	Geomatics Unit
Data source:	Statistics Canada, 2001 Census of Agriculture
Date:	March 25, 2004

Figure 11: 2001 Tame or Seeded Pasture

Lower Souris River Watershed
2001 Natural Land for Pasture



Saskatchewan Agriculture, Food and Rural Revitalization

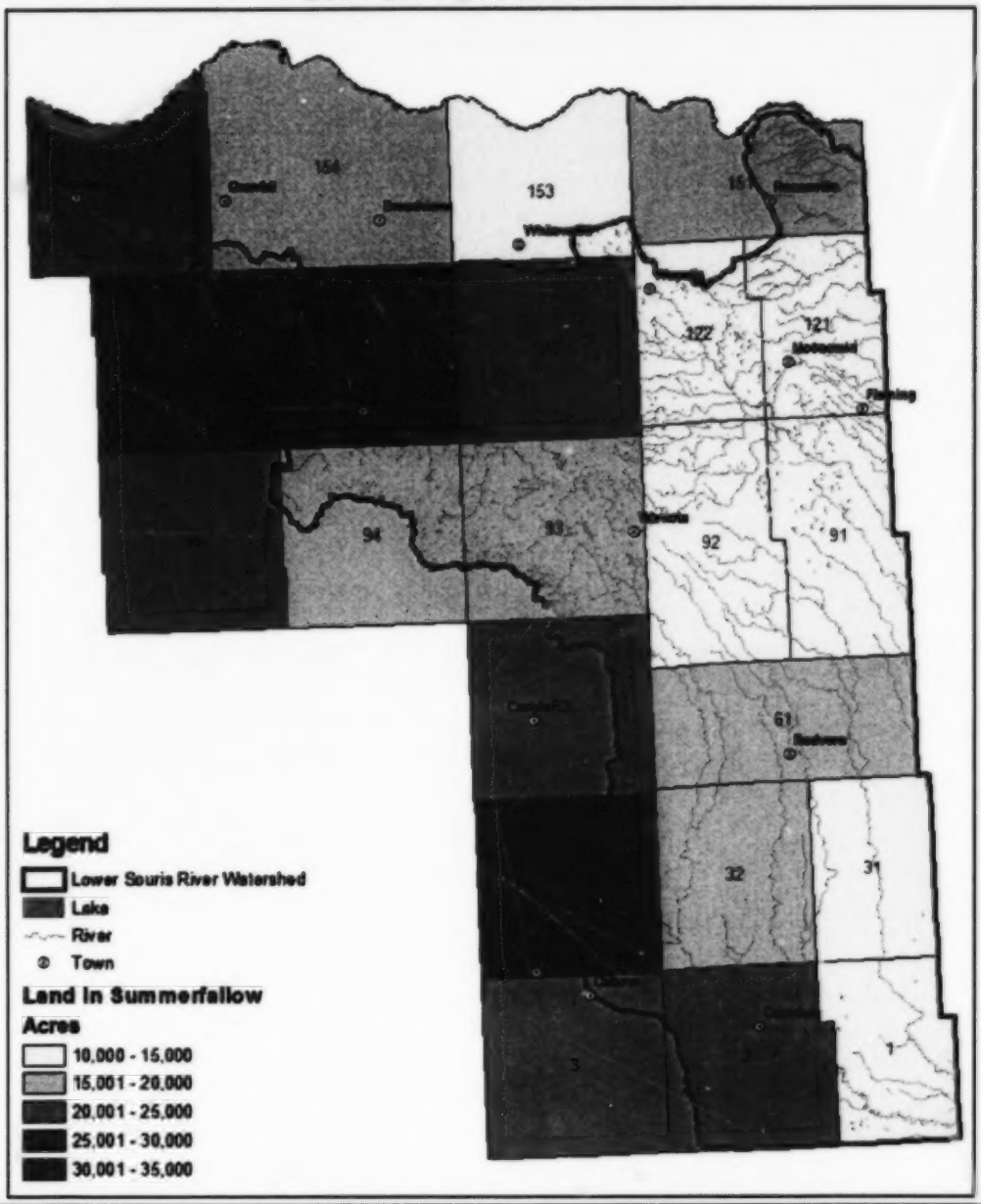
0 5 10 20 30 40
Kilometers

Prepared by:	Geomatics Unit
Data source:	Statistics Canada, 2001 Census of Agriculture
Date:	March 25, 2004

Figure 12: 2001 Natural Land for Pasture

Lower Souris River Watershed

2001 Land in Summerfallow



Saskatchewan Agriculture, Food and Rural Revitalization	0 5 10 20 30 40 Kilometers	Prepared by:	Geomatics Unit
		Data source:	Statistics Canada, 2001 Census of Agriculture
		Date:	March 25, 2004

Figure 13: 2001 Land in Summerfallow

Lower Souris River Watershed

2001 Tillage Incoporating Most Crop Residue Into Soil

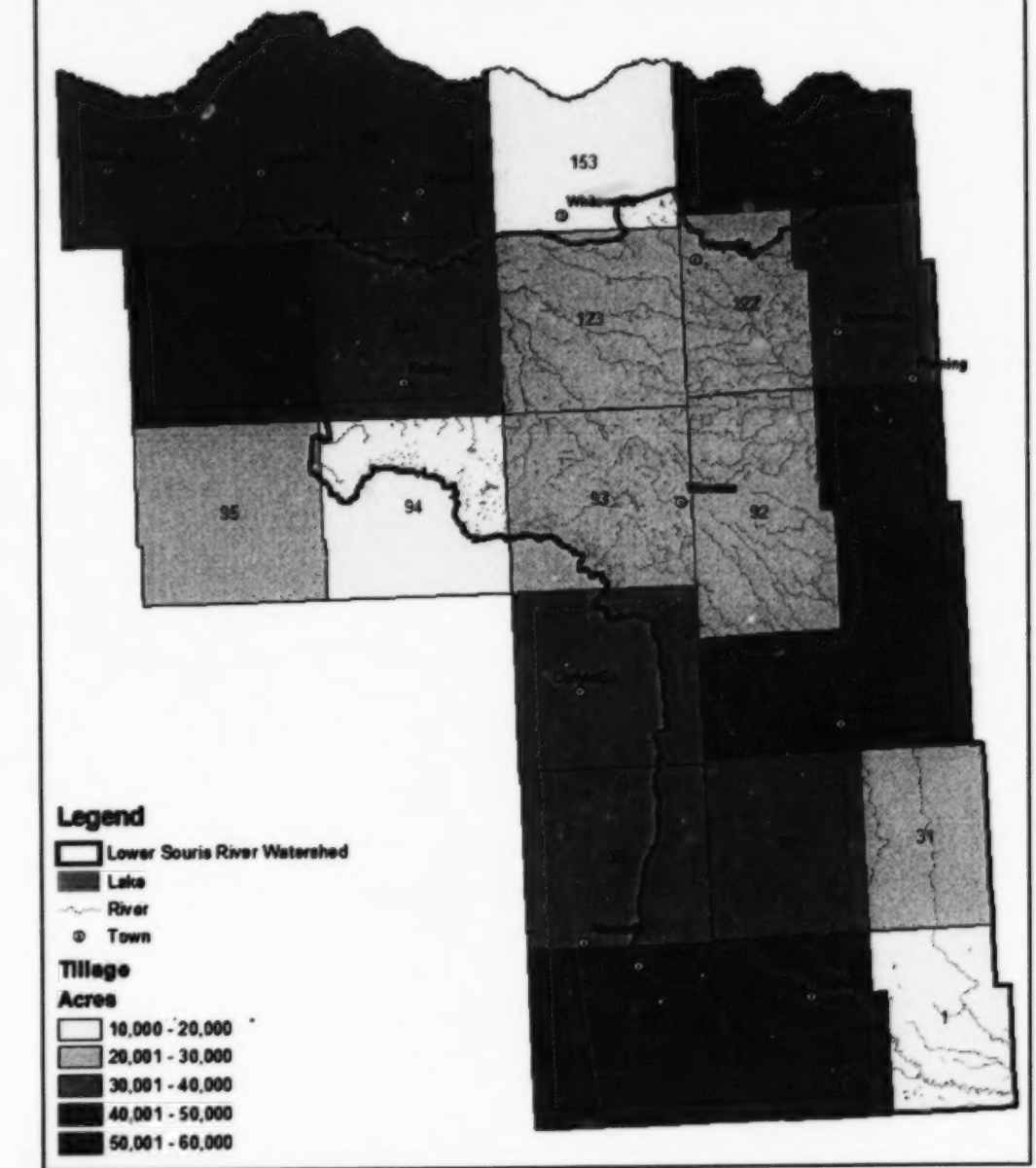
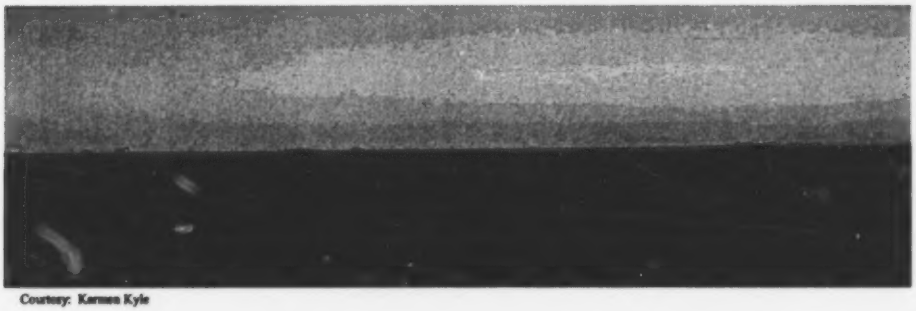


Figure 14: 2001 Tillage Incorporating Most Crop Residue into Soil

returns. Fusarium infections in the past decade have shifted the acres away from durum and malt barley and have provided production challenges for producers who continue to grow these crops. High humidity and precipitation in the recent past have limited (and in some cases eliminated) production of high-value specialty crops such as chickpeas and lentils. However, there is a stable group of producers in the district who have shown flexibility in their crop choices in response to global market demands and prices.



Courtesy: Karmen Kyle

Glossary

Crow rate – A federal program that subsidized the transportation of western grain to shipping ports. It was eliminated from the federal budget in 1995
BSE – Bovine Spongiform Encephalopathy is a progressive, fatal disease of the nervous system in cattle
Fusarium infection – A fungus that affects cereal grains by reducing yields
Inorganic fertilizer – A fertilizer artificially produced by mixing chemical compounds
Organic fertilizer – A fertilizer derived from a natural product like composted plant material
Pathogen – An agent causing disease

3.2 Oil and Gas Industry

Saskatchewan Industry and Resources' mandate, regulations and policies within the Oil and Gas Conservation Act, the Oil and Gas Conservation Regulations 1985, the Mineral Resources Act, and the Seismic Exploration Regulations 1999 assist in groundwater protection. A summary of Saskatchewan Industry and Resources' regulations pertaining to ground water protection is located in this report under Water Management and Legislative Framework. Figure 15 shows the oil and gas industry's current activities in the Lower Souris River Watershed.

The Canadian Association of Petroleum Producers (CAPP) has a 170 organization membership. Although this membership basis is a small percentage of the organizations, it accounts for 85 percent of the total production in Canada. Members of CAPP must pay a large membership fee which finances various studies looking to improve environmental sustainability of oil and gas production. Efforts are on addressing issues and forward thinking of concerns that the industry faces. Some of these issues include surface and groundwater resources, greenhouse gases, regulations, best management practices and safety.

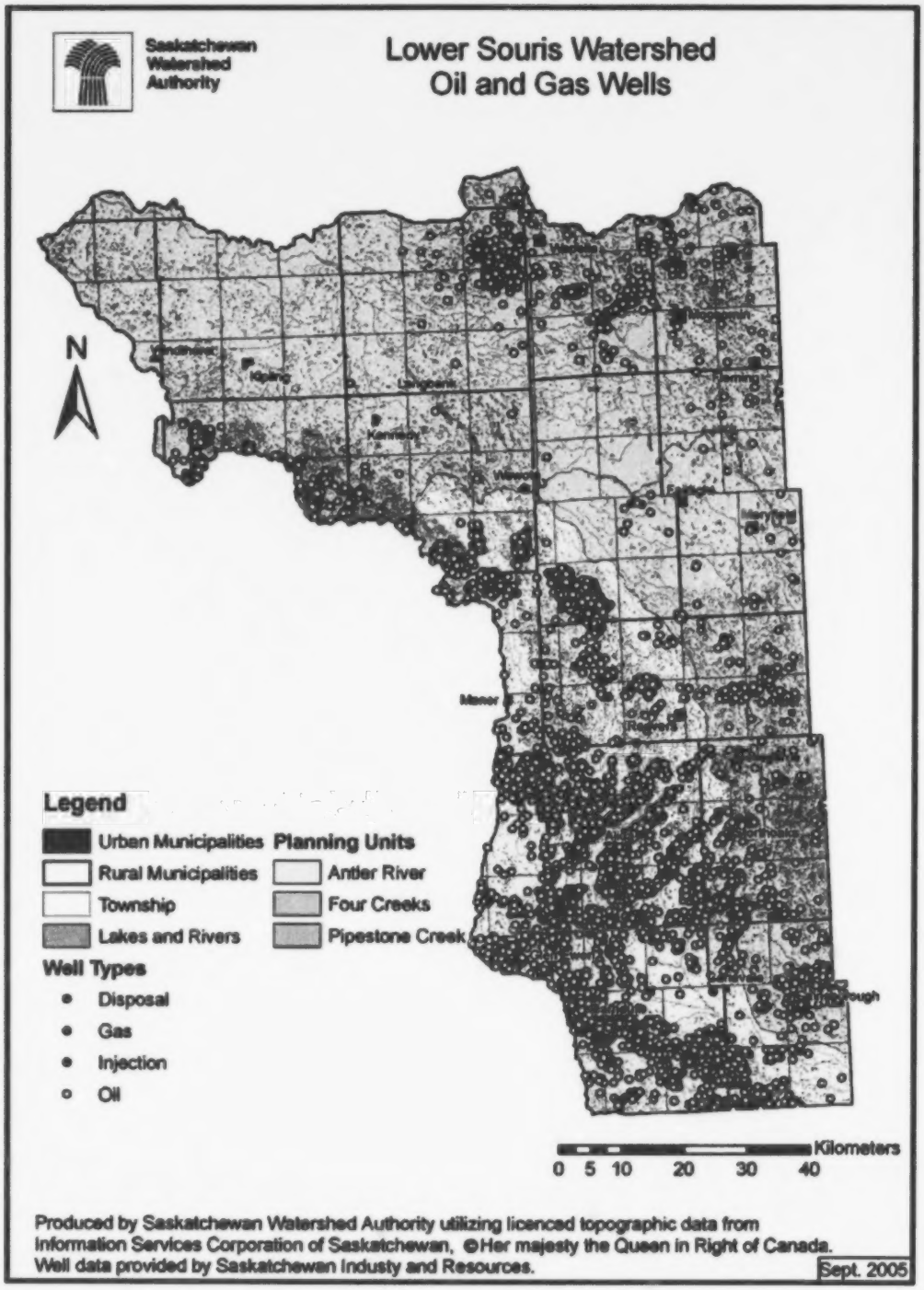


Figure 15: Oil and Gas Wells

4.0 Water Resources

4.1 Surface Water Resources

4.1.1 Pipestone Creek Planning Unit

The mean annual precipitation for the Pipestone Creek Planning Unit varies from about 415 millimetres near Broadview to about 460 millimetres at Kipling to about 510 millimetres at Moosomin (Environment Canada). Only 2.4 percent of the precipitation flows out of the basin as surface water under natural conditions.

Over the past four decades, streamflows of Pipestone Creek have been monitored by Environment Canada at three different locations and for different time periods as outlined in the following table. In addition to the three streamflow stations, there is also a water level station on Moosomin Reservoir (Figure 16).

Station Number	Station Name	Station type	Years of Operation	Location
05NE001	Pipestone Creek near Moosomin	Flow, eight month	1958-94	NW28-12-31-W1
05NE002	Moosomin Reservoir	Level, eight month	1955-present	NW29-12-31-W1
05NE003	Pipestone Creek above Moosomin Reservoir	Flow, eight month	1960-73, 1987-present	NW32-13-32-W1
05NG024	Pipestone Creek near the Saskatchewan Boundary	Flow, 12 month	September 1982 - present	NE18-10-29-W1

Table 1: Hydrometric Stations in the Pipestone Creek Watershed

In Manitoba, the West Souris Conservation District has two water quality monitoring stations on Pipestone Creek; one is located near the Saskatchewan - Manitoba border and the other is near the confluence of Oak Lake.

Figure 17 shows the annual flow volumes recorded at each of the three streamflow stations. Annual volumes range from essentially zero in the early 1960's and late 1980's to a recorded maximum of over 188,000 dam^3 in 1976 below Moosomin.

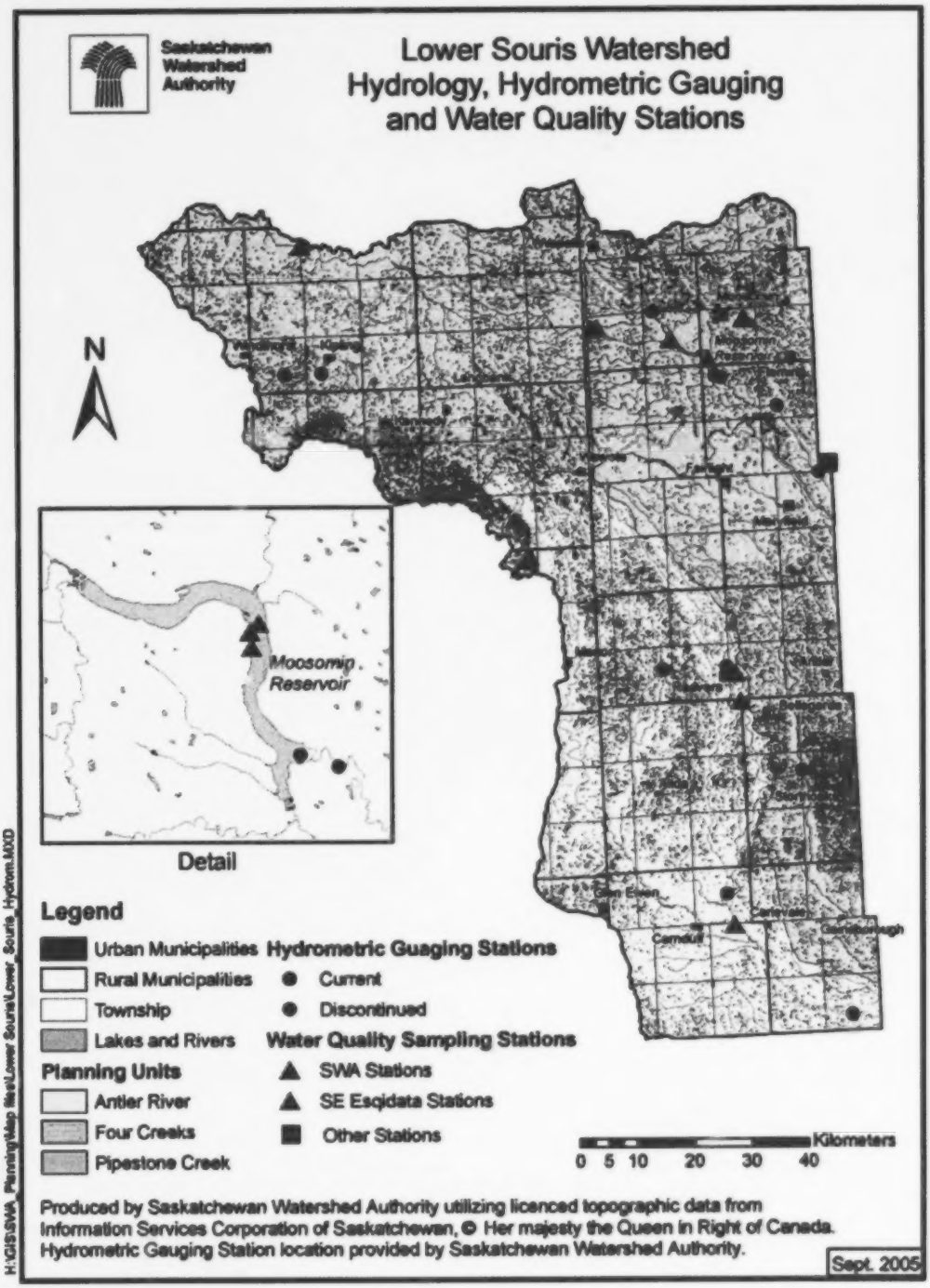


Figure 16: Hydrology, Hydrometric Gauging and Water Quality Stations

Figure 17: Annual Volume of Pipestone Creek

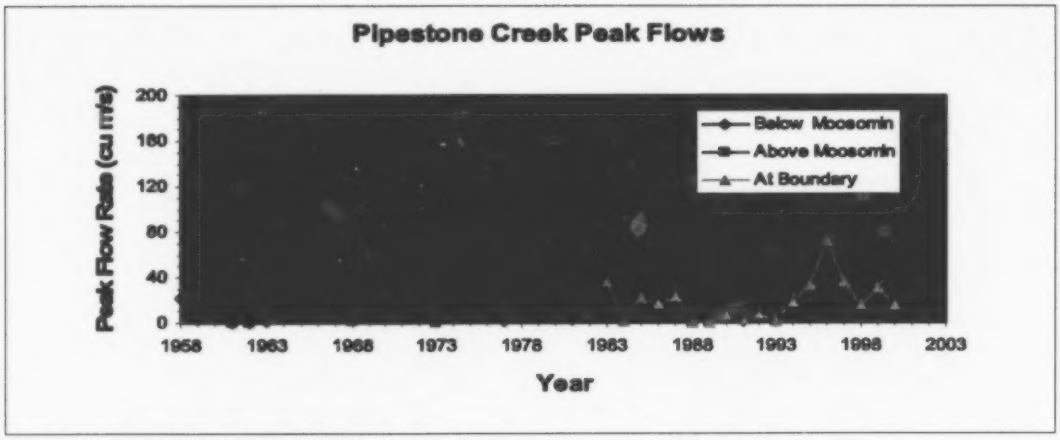


Figure 18: Pipestone Creek Peak Flows

Figure 18 shows the high degree of variability in peak flows in the watershed. The largest recorded flow occurred in 1976 when peak flows below Moosomin Dam were 176 m^3/s.

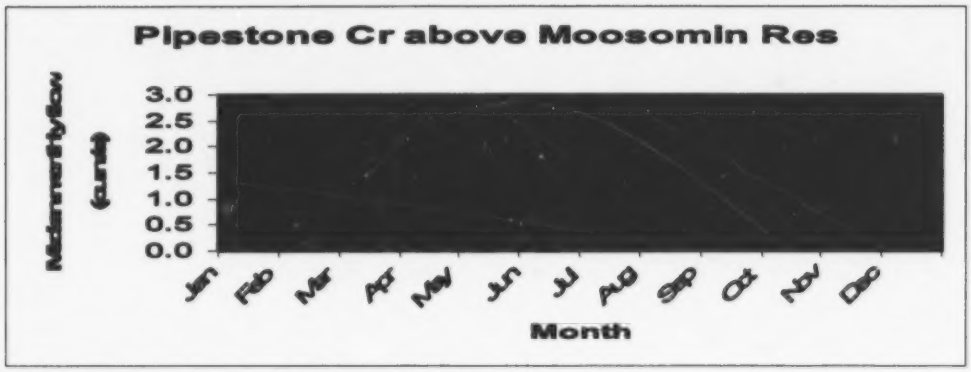


Figure 19: Pipestone Creek Monthly Flow Variation

Figure 19 shows that flow varies throughout the year, with the highest flow months typically being May and June.

Surface Water Use

There are 24 domestic surface water projects scattered throughout the Pipestone creek Planning unit with either Approval to Construct (AtC) or Approval to Operate (AtO) from the Saskatchewan Watershed Authority. Diversions to these projects total 94 dam^3 per year. Water use from these 24 domestic projects may be for in-home use, garden watering, watering of livestock, and/or spray water.

There is only one industrial surface water allocation in the Pipestone Creek Planning Unit held by the Canadian National Railway for a dam near Kelso on a tributary of the Little Pipestone Creek. The allocation allows for use of 160 dam^3 per year and evaporation loss of 37 dam^3 per year for a total diversion of 197 dam^3. It is likely safe to assume the only current use is the evaporation loss.

There are a total of 13 projects in the Pipestone Creek Planning Unit listed as either "Other" or "Multiple" in the Saskatchewan Watershed Authority Water Rights database. Moosomin Reservoir is the largest single surface water use in the basin, with allocation for water use of 4,687 dam^3 and evaporation losses of 617 dam^3. The 1992 Prairie Provinces Water Board Study estimated the current long-term average annual net evaporation loss from Moosomin Reservoir to be 1,660 dam^3 per year. There are currently two irrigation projects that are allocated 139 dam^3 of water from the reservoir; the golf course located on the east side of the dam is estimated to use 57 dam^3 of water from the reservoir. An allocation of 440 dam^3 is allotted for municipal use. The remaining 12 projects are owned by Ducks Unlimited Canada and represent total diversions of 1,262 dam^3. It should be noted that most Ducks Unlimited Canada projects involve water level control structures on existing wetlands which allow for stabilization of the water level and occasional manipulation of water levels to achieve optimum duck breeding and rearing habitat. In many cases, the normal operating level of the project is lower than the original natural outlet of the wetland. The diversions to these projects for the most part are for evaporation losses which would have occurred without the project. The authorization secures Ducks Unlimited Canada the right to access water for their purposes. Figure 20 shows the area where all the projects are located.

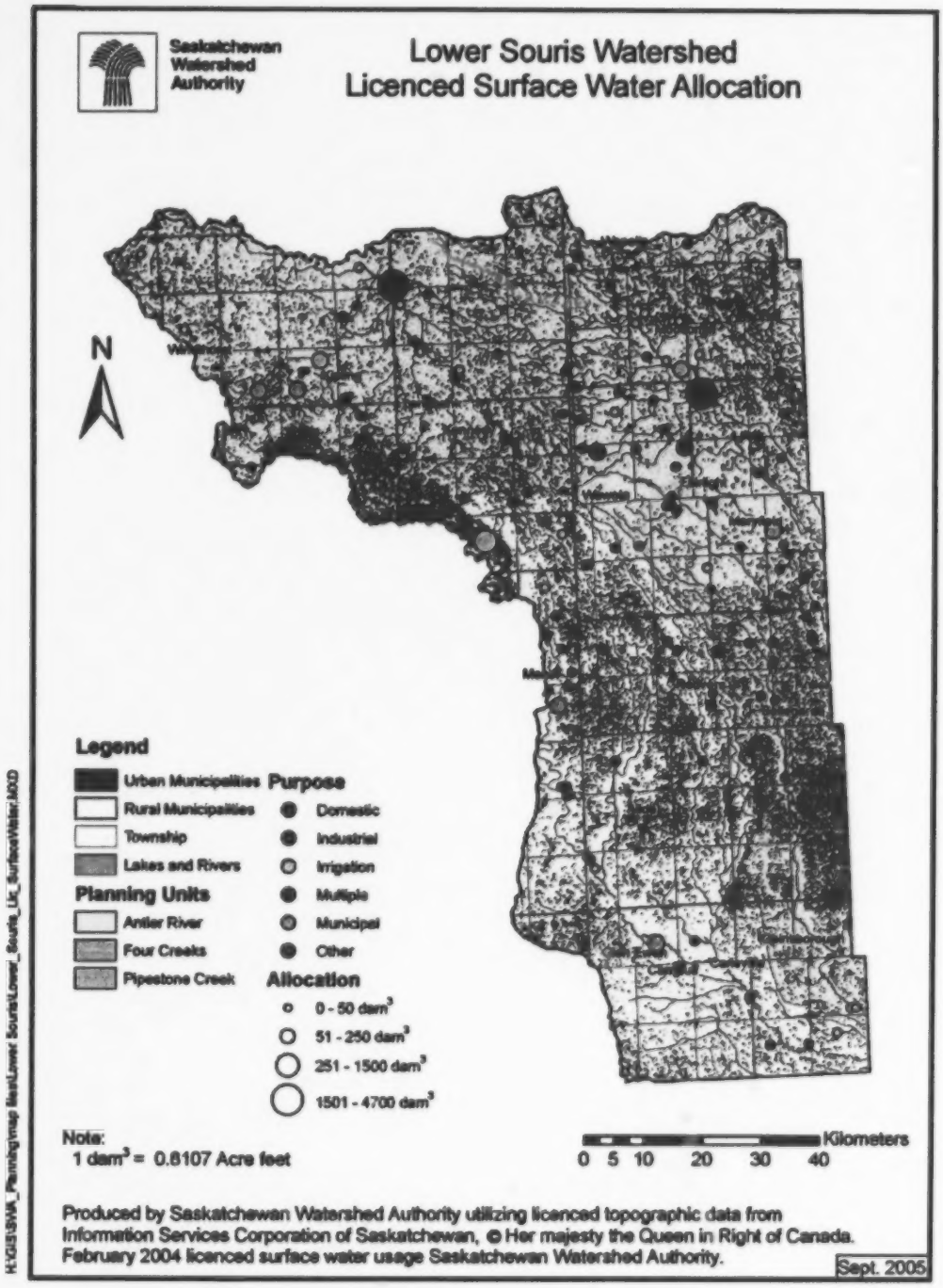


Figure 20: Licensed Surface Water Allocation

Water Quality

This section reviews and assesses the existing available water quality data for the Saskatchewan portion of the Lower Souris River Watershed. The data in Saskatchewan mainly corresponds to municipal wastewater effluent releases and is therefore not a reflection of the overall water quality of a water body and is therefore not conducive to analysis.

Moosomin Reservoir has a data set that permits interpretation. Concern over water quality in the reservoir led to the formation of a stewardship group between local residents and the Saskatchewan Watershed Authority (SWA) (then SaskWater) in 2001. Since then SWA, with the assistance of the local stewards, has conducted sampling on the Reservoir. Current sampling includes a baseline site across from the Regional Park store, as well as two shoreline sites. In 2003 a site upstream of Pipestone Creek on the 709 grid was introduced, while in 2004, two sites near stewardship project sites were sampled.

The sample data for Moosomin Reservoir was put into a Water Quality Index (WQI). The WQI is an effective means for summarizing a large number of water quality parameters and provides an indication of overall water quality. The index compares values for various water quality parameters (i.e. nutrients, dissolved minerals, metals) to water quality objectives. The results of those comparisons are combined to provide a water quality ranking system (excellent, good, fair, poor) for each individual water body. The ratings are compiled based on a combination of three factors - scope, frequency and amplitude. Scope refers to the total number of tested parameters whose objectives are exceeded. Frequency is the number of times the objectives are not met. Finally amplitude is the amount by which the objectives are not met. Listed below is a description of the ratings system on a scale of 0 to 100.

Excellent: (WQI Value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels. These index values can only be obtained if all measurements are within objectives virtually all of the time.

Good: (WQI Value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair: (WQI Value 60-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

Marginal: (WQI Value 45-59) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor: (WQI Value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

The WQI score for Moosomin Reservoir is in the fair range.

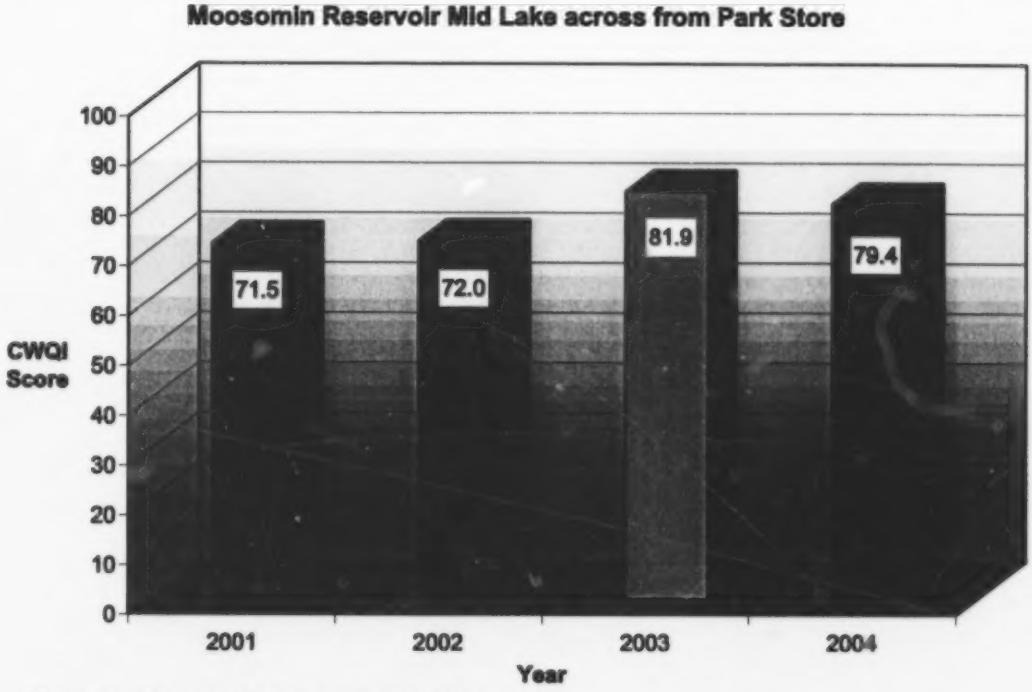


Figure 21: Moosomin Reservoir Water Quality

The WQI parameters and the SWA objectives are listed in Table 2 below:

Chloride Dissolved	100 mg/L
Arsenic Total	50 ug/L
Chromium Total	0.02 mg/L
Nitrogen Total Ammonia	Temperature & pH dependent - reported in mg/L
Mercury	0.1 ug/L
Sodium Dissolved	100 mg/L
pH	6.5 - 8.5
Dissolved Oxygen	5 mg/L
2`4-D	4 ug/L
MCPA	0.025 ug/L
Fecal Coliform	200 units/100 mL
Sulphate	500 mg/L
Phosphorous Total	0.1 mg/L
Aluminium Total	5 mg/L
Nitrogen Dissolved - NO3 & NO2	1 mg/L
Total Dissolved Solids	700 mg/L
Chlorophyll a	50 ug/L

Table 2: Water Quality Index and Parameters

Three parameters are largely responsible for influencing the WQI for Moosomin reservoir – phosphorous, total dissolved solids and chlorophyll A.

Total phosphorus is a key and limiting nutrient space in algae and aquatic plant growth. Sources of total phosphorus include fertilizers, decay of organic matter, soaps and detergents, septic systems and sewage effluent. The WQI objective for total phosphorous, as set by the Saskatchewan Watershed Authority, is 0.1 mg/L. Total phosphorus can vary seasonally in lakes and streams. Increased stream velocity will cause natural erosion of stream banks and channels adding soil that contains natural phosphorous. Total phosphorous levels ranged from 0.09 to 0.34 mg/L.

Total dissolved solids (TDS) are a measure of the amount of dissolved substances in the water. For example, the ocean has a high amount of TDS, about 35,000 mg/L, as the total dissolved solids are deposited into it. Sources of TDS include soil erosion, discharge of municipal waste and industrial agricultural run-off and groundwater (springs). Levels for irrigation ideally should not exceed 700 mg/L. In Moosomin Reservoir, TDS levels ranged from 762 mg/L to 1192 mg/L.

Chlorophyll A is a green pigment found in plants and is used to measure the quantity of algae in a water body. Levels in the reservoir ranged from 5 to 172 ug/L. Levels below the Saskatchewan Watershed Authority WQI objective of 50 ug/L will still demonstrate algae growth.

Dissolved oxygen (DO) readings in the reservoir consistently remained above the 5 mg/L during the open water season. During the winter months, ice covering the reservoir does not permit oxygen to be reintroduced to the water from the environment. During March, sampling DO readings have shown to be near 1 mg/L during at the baseline site.

In 2003 pesticide and herbicide sampling was done on Moosomin Reservoir. The results returned were non-detectable, as pesticides and herbicides degrade rapidly in water. The tests are expensive and were not collected in 2004 because of limited financial resources. However, Saskatchewan Environment regularly collects pesticide and herbicide samples at their water quality monitoring stations in the province to detect any trends. (This is not to say that, if the advisory committee can obtain funding, they would not be performed.)

Water Quality Sampling on Moosomin Reservoir

Major Water Resources Development
Moosomin Reservoir

The Moosomin Dam is located on Pipestone Creek, NW 29-12-31 W1, approximately ten kilometres south of the town of Moosomin. Components of the project include a zoned earth-fill embankment with a maximum height of 13.5 metres. A low level riparian outlet is used to make controlled releases from the reservoir if the uncontrolled concrete spillway has no water flowing over it. The project was originally built to provide water conservation. Uses have expanded to include irrigation, water supply, and recreation, and to provide supplementary riparian flows.

Pipestone Creek Planning Unit above Moosomin Dam has a gross drainage area of about 3,646 square kilometres. Moosomin Reservoir has three main tributaries – Pipestone Creek, Little Pipestone Creek, and Montgomery Creek. Pipestone Creek rises south of Grenfell, while the headwaters for the other two tributaries begin at the north-facing slope of the Moose Mountain Hills.

The dam is located on the Pipestone Creek just downstream of the confluence of the Pipestone and Little Pipestone Creeks, about 28 kilometres upstream of the Saskatchewan – Manitoba border. Moosomin Reservoir has a storage capacity of about 11,155 dam^3 at its full supply level (FSL) and a dead storage volume of about 311 dam^3.

The dam is considered to be large, according to the standards set out by the International Commission on Large Dams and, as such, appears on its world wide inventory. Foundation seepage control measures for the dam include a granular filter zone in the downstream portion of the dam, a system of relief wells, and a natural clay blanket upstream of the embankment.

The spillway is a free overflow or uncontrolled reinforced concrete chute structure with a width of about 30.5 metres and a length of about 70 metres. The spillway is located on the south abutment of the project.

The low-level riparian outlet works is situated near the north end of the dam. The works include reinforced concrete components, inlet structure, 1.2 square meter conduit, gatewell, and outlet structure. The gatewell structure houses a vertical lift slide gate to allow small riparian releases downstream.

Pipestone Lake

Pipestone Lake was a natural lake until Prairie Farm Rehabilitation Administration constructed the dam across the outlet in 1939. The original purpose was to provide water for domestic and livestock use downstream. The volume of Pipestone Lake is listed as 1,973 dam^3, covers an area of 137 hectares and is licensed for 1505 dam^3 of use plus 345 dam^3 of evaporation losses. There are currently no direct uses out of the lake or licensed uses downstream that depend on releases. The control structure is currently not licensed and the free overflow spillway on the south end of the dam has eroded back to the natural lake level. Currently the Rural Municipality of Silverwood is responsible for the project.

4.1.2 Four Creeks Planning Unit

Stony, Jackson, Graham and Gainsborough Creek are classified as intermittent water courses, which means there is typically some flow during spring snowmelt followed by zero or near-zero flows through the late spring, summer, fall and winter, interrupted occasionally by runoff in the event of a very high rainfall event. Using the results of the three Prairie Provinces Water Board studies, the median runoff for Jackson, Graham, and Gainsborough Creeks at their inter-provincial boundary crossings are 4.4 mm, 6.4 mm, and 6.5 mm respectively. This compares with mean annual precipitation of 460 mm to 490 mm.

Gainsborough Creek
Courtesy: Four Creeks Watershed Inc.

Currently, Environment Canada has one hydrometric station operating on Lightning creek and two stations on the Antler River in Saskatchewan. Auburnton, Stony, Jackson, Graham and Gainsborough Creeks presently do not operate hydrometric stations.

Surface Water Use

There are currently five authorized projects in the effective portion of the Jackson Creek drainage area. In addition, there are two projects in the non-effective portion to the drainage area. With an estimated median annual natural flow volume of 276 dam^3, the estimated diversion represents nearly 40 percent of the natural flow volume.

There are currently three authorized projects in the effective portion of the Graham Creek drainage area. In addition, there is one project in the non-effective portion to the drainage area. With an estimated median annual natural flow volume of 330 dam^3, the estimated diversion represents only 6 percent of the median annual natural flow volume.

There are currently 15 authorized projects in the effective portion of the Gainsborough Creek drainage area. In addition, there is one project in the non-effective portion to the drainage area. With an estimated median annual natural flow volume of 3,350 dam^3, the estimated current diversion represents 21 percent of the median annual natural flow volume. Figure 18 shows the areas where all projects are located.

Water Quality

Currently, the only water quality information available for Stony, Graham, Jackson and Gainsborough Creeks are from effluent releases by community lagoons (data collected by Saskatchewan Environment) and by West Souris Conservation District's sampling stations located in Manitoba.

Major Water Resources Development
Gainsborough Dam

Gainsborough Dam is located approximately 13 kilometres south east of Gainsborough on Gainsborough Creek. The project was constructed in 1976 by the Prairie Provinces Water Board for municipal purposes. The control structure is currently licensed and operated by the Rural Municipality of Argyle. The volume of Gainsborough Dam is listed as 1101.1 dam^3 covering an area of 70.8 hectares and has an allocation of 25 dam^3.

4.1.3 Antler River Planning Unit

The mean annual precipitation for the Antler River Planning Unit varies from around 430 mm at Carlyle to about 525 mm at Carnduff. While a very small percentage of the received water may recharge groundwater systems, the vast majority of the water received is returned to the atmosphere either through evaporation from wetlands and the ground surface, or through transpiration from plants.

Streamflows of Antler River are available from Environment Canada at three different locations for the time periods as outlined in the following Table 3. A fourth site, Antler River near Western Crossing was operated manually between 1978 and 1986 for miscellaneous measurements. In addition to the Environment Canada streamflow stations, the Prairie Provinces Water Board monitored water levels of the Redvers Reservoir for a number of years.

Station Number	Station Name	Years of Operation	Location
05NF002	Antler River near Melita	1935-36, 38, 43-present	NE 01-27-01-W1
05NF006	Lightning Creek near Carnduff	1935-36, 73-present	NE 15-03-32-W1
05NF010	Antler River near Wauchope	1965-present	NW 24-7-33-W1

Table 3: Hydrometric Stations in the Antler River Watershed

Annual flow volumes (Figure 22) range from zero in the early 1960's and late 1980's to a recorded maximum of over 186,000 dam^3 in 1976 near Melita.

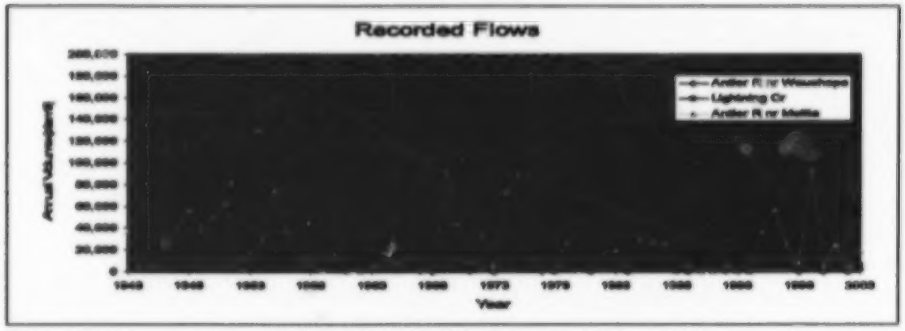


Figure 22: Annual volumes recorded at each of the three streamflow stations.

Similarly there is a high degree of variability in peak flows in the watershed as shown in Figure 23. The largest recorded flow occurred in 1976 when peak flows near Melita were 118 m^3/s.

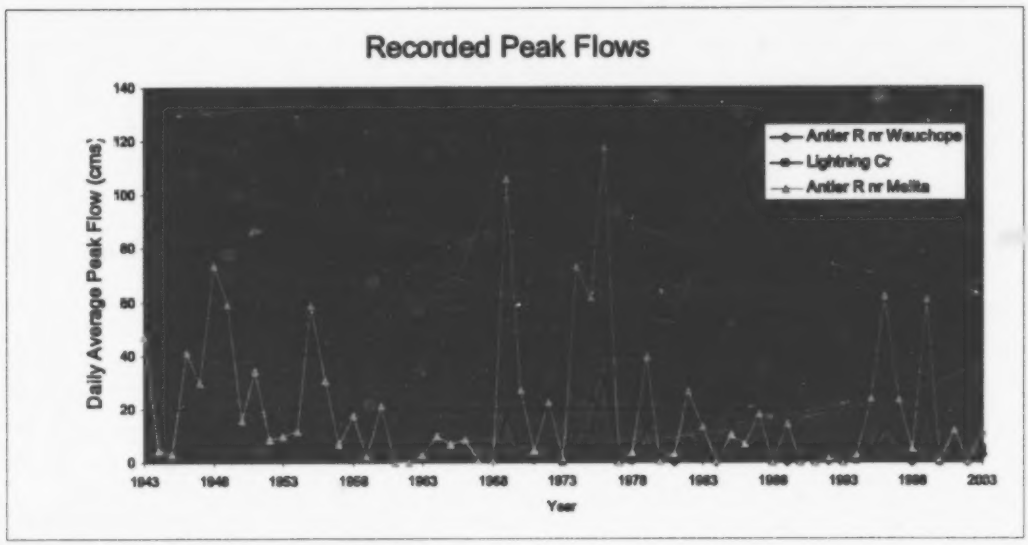


Figure 23: Recorded Daily Average Peak Flows

Flows vary throughout the year with the highest flow months typically being April (Figure 24). After the snowmelt peak, flows typically recede over the summer months and are often zero by mid-summer to late fall.

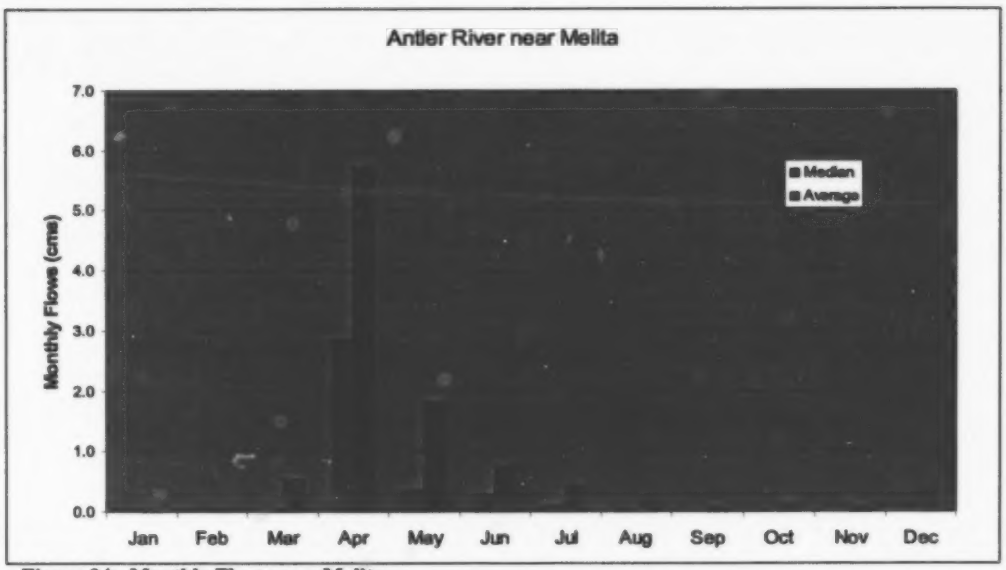


Figure 24: Monthly Flows near Melita

Surface Water Use

The largest single water demand on Antler River is the obligation under the 1969 Master Agreement on Apportionment for Saskatchewan to provide to Manitoba 50 percent of the natural flow of the creek at the Saskatchewan-Manitoba boundary. The 1978 Prairie Provinces Water Board Study examined the ability of Saskatchewan to meet this obligation with the water demands and projects in place as of 1977. The study found that the average annual water use at the time amounted to about 5 percent of the average annual natural flow (21,900 dam^3) at the boundary. In extremely dry years, water use in the Saskatchewan portion of the basin would approach 50 percent of the natural flow.

There are 22 domestic surface water projects scattered throughout the Antler River Planning Unit. Allocations to these projects total 92 dam^3 per year. Water use from these projects may be for in-home use, garden watering, watering of livestock, and/or spray water.

There are four authorized irrigation projects in the Antler River Planning Unit. Allocations to these projects total only 33 dam^3. In addition, the Auburnton Reservoir is registered as an irrigation project; however, no irrigation has been developed out of the reservoir. Auburnton Reservoir has storage capacity of 2,160 dam^3 and a surface area of 83.0 hectares.

There are two projects in the Antler River Planning Unit listed as "Other" in the Saskatchewan Watershed Authority Water Rights database. Both are projects owned and operated by Ducks Unlimited Canada with combined licensed diversions of 296 dam^3. There are no industrial surface water allocations in the Antler River Planning Unit.

Water Quality

Currently, the only water quality information available for Antler River, Lightning and Auburnton Creek is from effluent releases by community lagoons (data collected by Saskatchewan Environment) and by West Souris Conservation District's sampling stations located in Manitoba.

Major Water Resources Development

Redvers Dam

Redvers Dam, two kilometres north of Redvers, is located on Lightning Creek. The project was constructed in 1961 by Prairie Farm Rehabilitation Administration for multi-purpose use including groundwater recharge for Redvers' community wells. The control structure is currently licensed and operated by the Rural Municipality of Antler. In 1992, the reservoir was deepened as part of a joint fisheries project between the community of Redvers, the Redvers Wildlife Federation and the Fish and Wildlife Development Fund. The volume of Redvers Dam is listed as 235 dam^3 covering an area of 19 hectares and has no water allocation.

Auburnton Dam

Auburnton Dam is located approximately four kilometres southeast of Manor on Auburnton Creek. The project was constructed by Prairie Farm Rehabilitation Administration in 1949 (with a formal agreement) at the request of the Rural Municipality of Reciprocity. Land control and

an approval to construct were not obtained, nor was a water license issued, but Prairie Farm Rehabilitation Administration did obtain authorization to construct from the Saskatchewan Water Rights Branch in 1957. Prairie Farm Rehabilitation Administration maintained the project between 1949 and 1968 with various minor repairs to the spillway and riparian outlet. In 1969, Prairie Farm Rehabilitation Administration replaced the original upstream sloping gate of the riparian outlet with a gatewell and vertical lift gate and relined the conduit. Prairie Farm Rehabilitation Administration has not preformed any additional maintenance or repairs since 1969. The project is located on privately-owned land and is operated primarily for the individual's benefit with no interest in the project from other users or the rural municipality. In 1980, the Federal Department of Justice indicated that Prairie Farm Rehabilitation Administration had no legal responsibility to maintain or repair the dam. Prairie Farm Rehabilitation Administration has not been formally involved with the project since that time.

The dam is a 518 meter long, earth-fill embankment with a top width that varies from seven to eight metres. The emergency spillway was severely eroded in the spring of 1969. The sheet piles installed in 1961 have been breached and three- to four-meter high vertical erosion banks have developed on each side of the channel.

The volume of Auburnton Dam is currently listed as 2,158 dam^3 covering an area of 83 hectares and has no water allocation.

4.2 Apportionment

Prairie Provinces Water Board (PPWB)

The Prairie Provinces Water Board was formed on July 28, 1948 when Canada and the provinces of Alberta, Saskatchewan and Manitoba signed the Prairie Provinces Water Board Agreement. During the next 22 years (1948 to 1969 inclusive), the Engineering Secretary to the Board was a Prairie Farm Rehabilitation Administration employee. The support staff for studies and office accommodation during these years was provided by the Prairie Farm Rehabilitation Administration in Regina at no charge. On October 30, 1969, Canada and the three provinces entered into an agreement to share the flow and to consider the quality of eastward flowing inter-provincial streams. The following schedules outline the portion of the Prairie Provinces Water Board agreement that is pertinent to the Lower Souris River Watershed:

Schedule B: Agreement between Saskatchewan and Manitoba
This agreement defines the natural flow, point of apportionment and apportionment principles. Saskatchewan is entitled to keep one half of the natural flow arising in Saskatchewan.

Schedule E: Water quality Agreement amended in 1992
Alberta, Saskatchewan and Manitoba are required to try their best to meet the water quality objectives established by the Board.

In addition to the apportionment monitoring activities, the Prairie Provinces Water Board staff periodically compute the apportionment balance of Pipestone Creek at the Saskatchewan-Manitoba boundary. The information is then provided to Saskatchewan Watershed Authority and Manitoba Conservation for water management purposes. In 2002 a total of 19,518 dam^3 of water was passed to Manitoba, well above the required 50 percent.

Apportionment in the Lower Souris River

Prior to 1983, Saskatchewan always met the required 50 percent of natural flow to Manitoba for all tributaries in the Lower Souris River. Since 1983, Pipestone Creek has not met the apportionment requirement in 1984, 1988 and 1989. From the recorded and natural monthly flows, attempts in those three years were made to meet the shortfall of water through fall releases out of Moosomin Reservoir.

Since there is less development and no large storage projects on Stony, Graham, Jackson, Gainsborough Creeks and Antler River, these tributaries will continue to meet required natural flows to Manitoba.

4.3 Groundwater Resources

Ground water is the water below the land surface. There are no underground streams, rivers or lakes in Saskatchewan. Rather, water moves through the inter-granular openings and fractures in rocks and sediments. The ease at which fluid will flow, or *permeability*, increases the coarser the sediment. Thus, gravel is more permeable than sand, which is in turn more permeable than clay.

Where a saturated geologic unit is sufficiently permeable to yield water to a well economically, it is termed an aquifer. In general, aquifers are sand and gravel deposits that are of sufficient extent and thickness. A saturated geologic unit which is sufficiently permeable to transmit reasonable amounts of water over large areas, but cannot yield water to a well economically is termed an *aquitard*. Aquitards generally consist of silts, clays and till. A basic understanding of the occurrence of these geologic deposits is necessary to understand the occurrence of ground water resources, thus, a basic understanding of the geologic history of the area is necessary to understand the ground water resources.

In its simplest state, two types of geologic deposits are considered to be present, glacial drift and bedrock. Based on their history, these deposits have been separated and classified into formations. Figure 25 shows a very simplified schematic cross section of the geology in the study area.

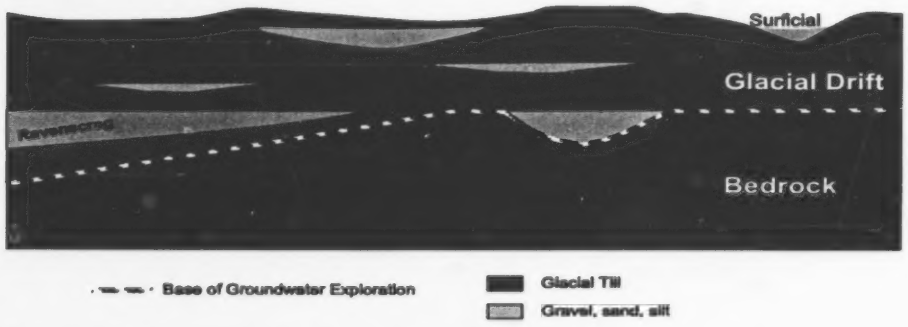


Figure 25: Schematic cross-section of the Lower Souris geology

Bedrock formations consist of sediments deposited prior to the glaciers. Bedrock formations are generally aerially extensive, of a relatively uniform thickness and often of a more consistent make up, or *lithology,* than glacial deposits. A thick clay bedrock known as the Pierre Shale Formation underlies the entire study area. Above the clay are two bedrock formations which form aquifers: the Eastend-Frenchman Formation and the Ravenscrag Formation. Although up to 125 metres thick in the extreme southwest of the basin, these formations thin in a north-easterly direction until they are no longer present, as can be seen in Figure 26, the plan view of the bedrock surface.

A series of glaciers advanced and retreated over the area in more recent geologic history. The glaciers eroded, reworked, transported and ultimately re-deposited bedrock sediments. Material originally mixed up in the ice was either deposited as an unsorted mixture of sand, silt, clay and rocks, or re-sorted by melt water into more homogenous deposits. Glaciers advanced and retreated a number of times, and each time the process was repeated, producing a conglomeration of past and present landforms. The result is a very complex combination of sand, silt and clay deposits, often in layers. The deposits are much more variable in extent, thickness and lithology than bedrock layers, and are collectively referred to as *glacial drift.* Drift is present throughout the study area and is generally about 100 metres thick, but can be over 200 metres thick in the Moose Mountain uplands. It consists largely of till (an unsorted mixture of sand, silt and clay sediments) which is very clay rich and, thus, is mostly an aquitard. However, areas of sand and gravel that have been sorted often form aquifers. The extent of aquifers varies both horizontally and vertically, thus aquifer occurrence is three dimensional.

Figure 25 looks at the glacial drift in detail to illustrate how aquifers are grouped based on their vertical occurrence in the geologic profile. Aquifers occurring on top of the bedrock surface yet below glacial till are categorized as Empress Aquifers. There are two major drift classification groups in Saskatchewan, the Saskatoon and Sutherland Groups. In this report, aquifers occurring within the Sutherland Group and Saskatoon Group deposits are logically termed as such, while aquifers occurring between the two are termed *interglacial.* Figures 27 and 28 show the occurrence of the mapped aquifers based on where they occur vertically. It is acknowledged that this in no way represents all the aquifers which exist, only those that were able to be mapped on 1:250,000 scale (using the data available at the time). It is obvious from the figures that the majority of larger, mapped aquifers are in the northern third of the study area, while there is little in the southern portions with the exception of two buried valley aquifers.

Groundwater flow in the study area can generally be thought of as occurring within three zones. A zone of deep saline water is separated from water that is of tolerable quality for most uses by thick bedrock formations with very low permeability, the Pierre Shale being the uppermost. Thus, the top of the Pierre Shale Formation forms what is termed the *base of ground water exploration;* below that point a ground water supply is generally neither practical nor economically feasible for most uses.

Above the base of groundwater exploration, the next zone includes aquifers that generally receive their recharge via seepage from surrounding low permeability sediments or aquitards (most often till). This group of aquifers includes those occurring within the bedrock (the Frenchman and Ravenscrag formations present in the southwest corner of the study area), Empress Group, Sutherland Group, Interglacial and Saskatoon Groups. Although seepage rates through the till are very slow, over large areas the total recharge can amount to usable volumes of water, and thus this zone of aquifers represents probably the most heavily utilized source in the study area. While groundwater from these aquifers is usually somewhat

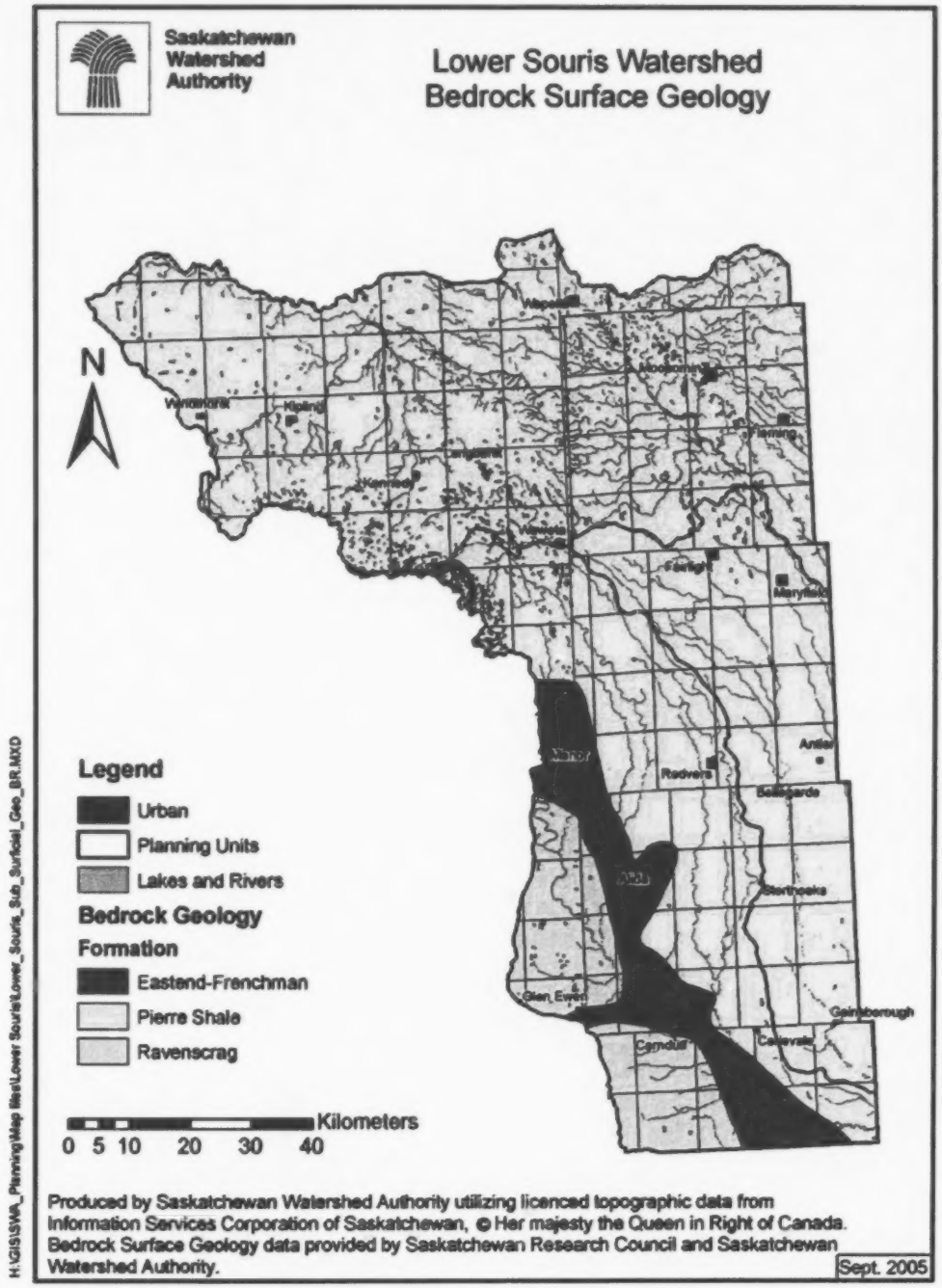

Saskatchewan Watershed Authority
Lower Souris Watershed
Bedrock Surface Geology
N
Legend
Urban
Planning Units
Lakes and Rivers
Bedrock Geology
Formation
Eastend-Frenchman
Pierre Shale
Ravenscrag
Kilometers
0 5 10 20 30 40
Produced by Saskatchewan Watershed Authority utilizing licenced topographic data from Information Services Corporation of Saskatchewan, © Her majesty the Queen in Right of Canada. Bedrock Surface Geology data provided by Saskatchewan Research Council and Saskatchewan Watershed Authority.
Sept. 2005
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Figure 26: Bedrock Surface Geology

mineralized, they are also much less vulnerable to both drought cycles and contamination from activities on the surface. Wells completed into these aquifers are most often of smaller diameter (10 to 15 centimetres) and are usually installed by mud rotary drilling.

The final groundwater zone is the shallow, near surface groundwater zone. The context of the term *shallow* here relates less to a specific depth and more to the fact that groundwater is directly and efficiently connected to surface phenomena, such as precipitation and land surface activities (i.e. there is no appreciable aquitard insulating the aquifer from the ground surface). Although the water quality is often much better than deeper zones, aquifers in this zone are more prone to drought and more vulnerable to contamination. Surface water bodies, including lakes, rivers and wetlands, can serve as either recharge or discharge areas depending on the local hydrogeology. In the study area, surficial aquifers are used primarily for domestic supplies because they have limited well yields. Well design and installation method can be of any type depending on a number of factors, but large diameter (approximately 75 centimetres in diameter) wells installed by a boring rig are common.

Figure 29 shows the distribution of well records in the Saskatchewan Watershed Authority drillers report database, while Figures 30 and 31 show the distribution of wells by purpose and by installation method. It is clear that the vast majority of wells are for individual domestic use, while municipal and industrial uses are next. Of all the well records, roughly half are for large diameter bored wells and half are for smaller diameter drilled wells. The same database also overwhelmingly suggests that wells have relatively low recommended withdrawal rates. In fact the recommended maximum pumping rate is less than 1.9 litres/second (25 lgpm) in 90 percent of records, and less than 0.76 litres/second (10 lgpm) in 70 percent of records. The low pumping rates reflect some combination of limiting factors, such as the permeability of aquifer sediments, aquifer thickness or water level, or limitations of the wells by the nature of their design (as most wells are designed and installed for domestic purposes only and use a more or less standard design).

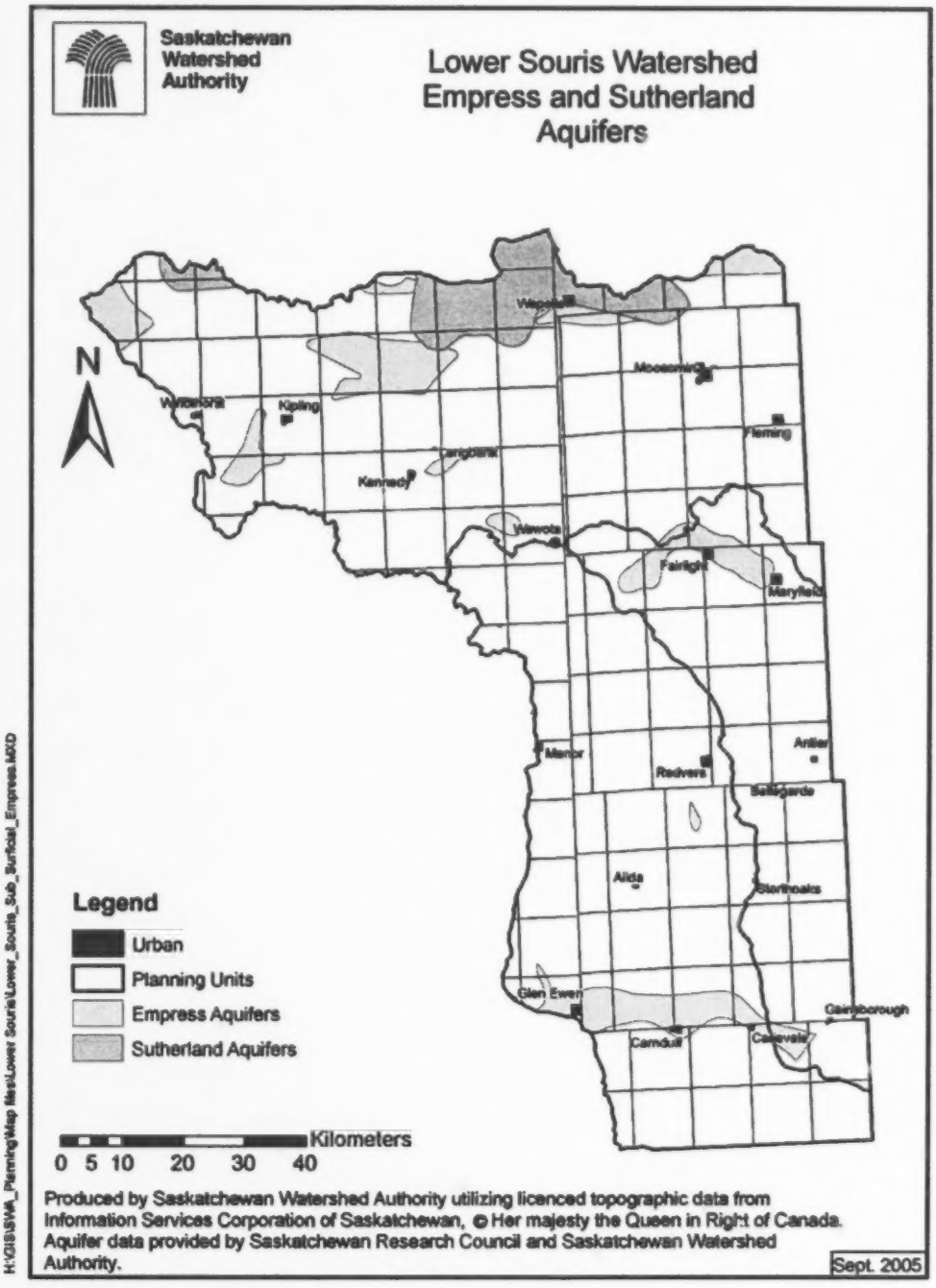

Figure 27: Empress and Sutherland Aquifers

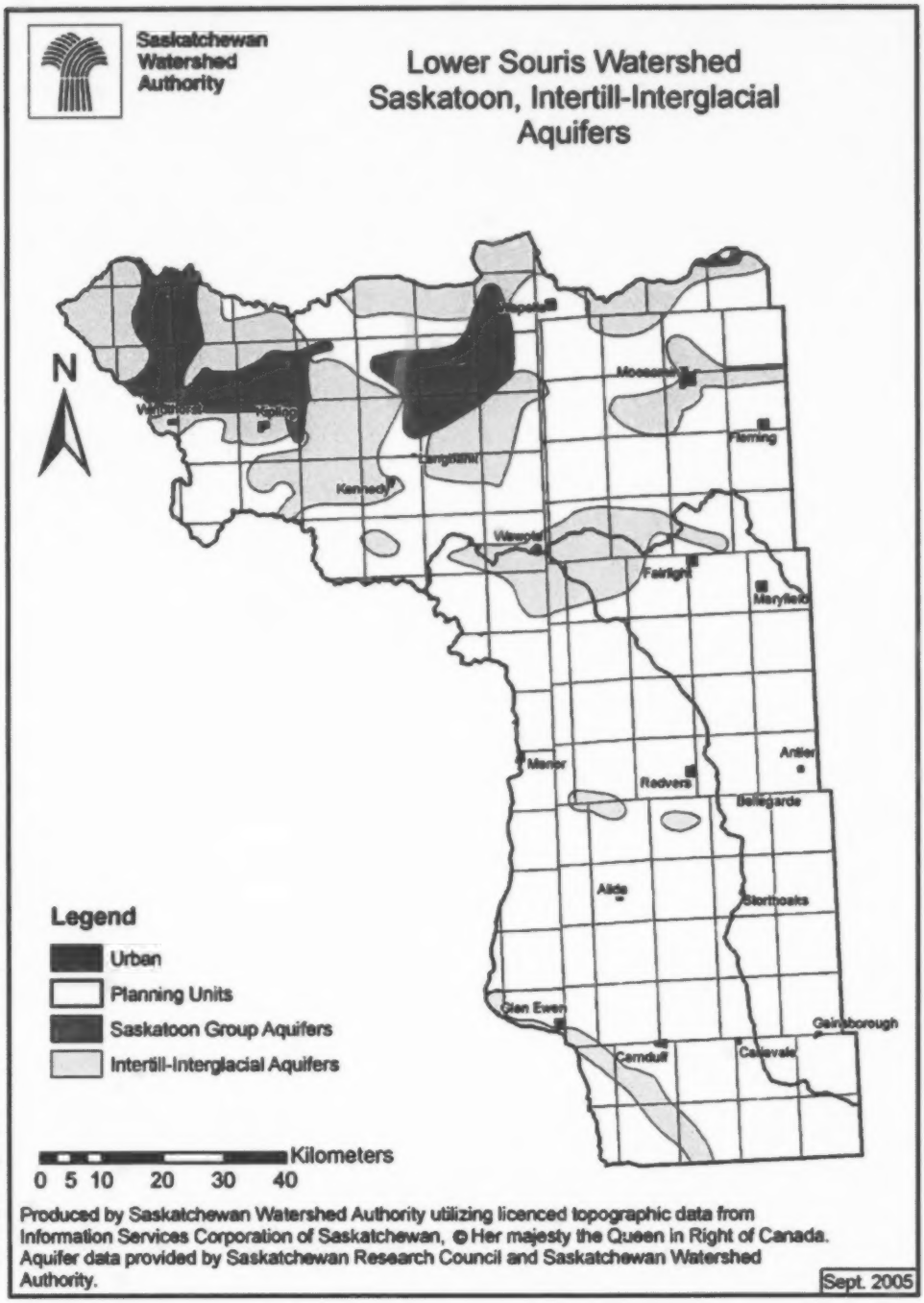

Figure 28: Saskatoon, Intertill-Interglacial Aquifer

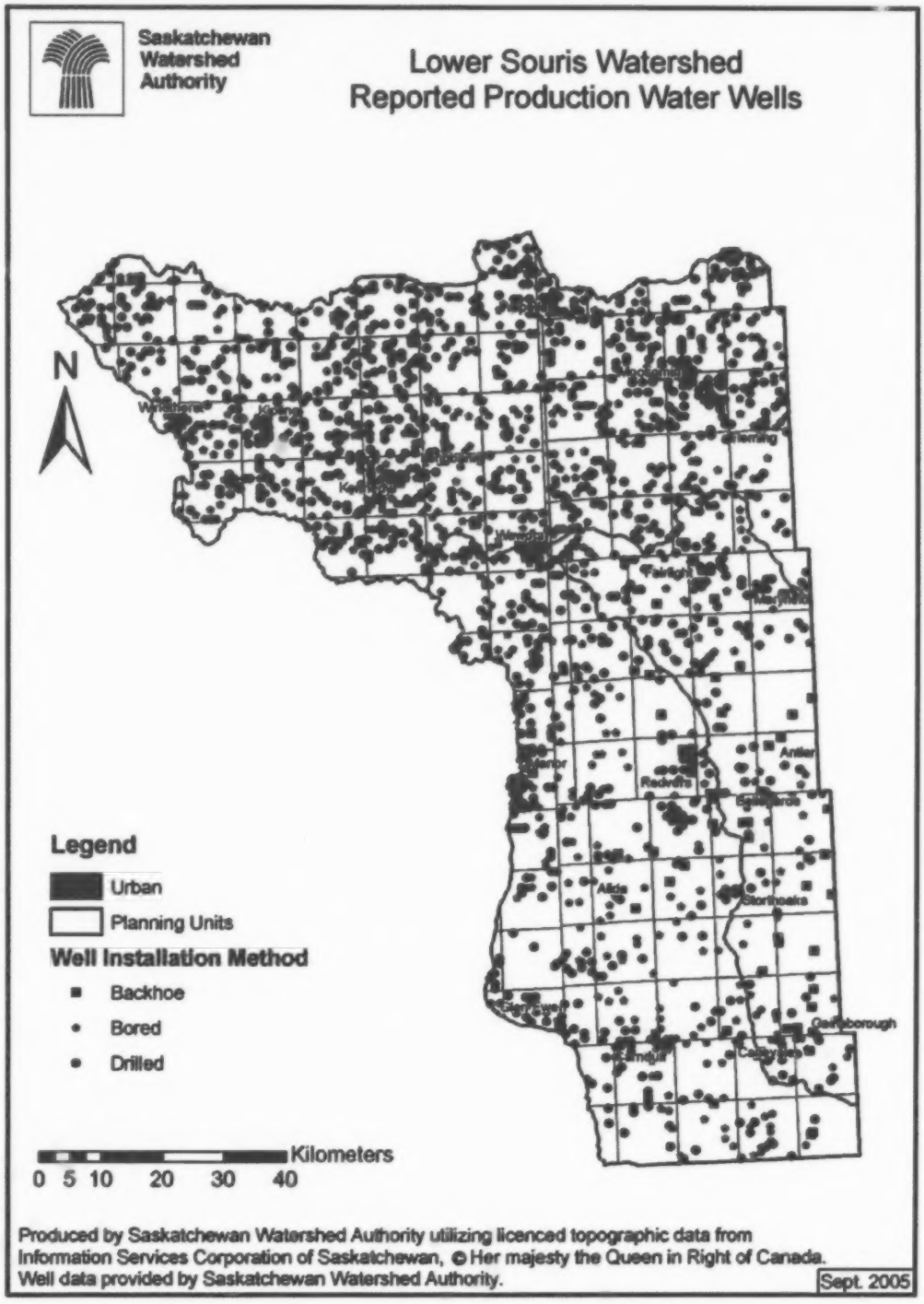

Figure 29: Reported Production Wells

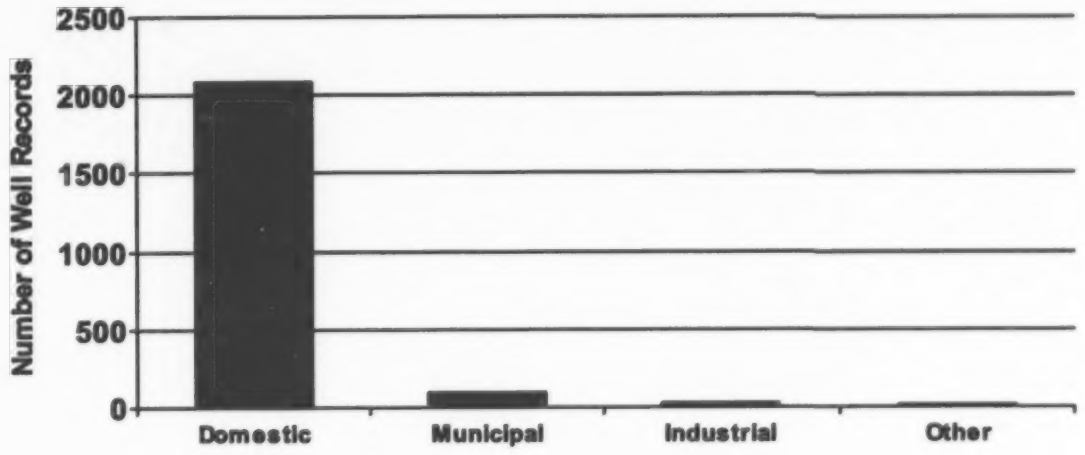

Figure 30: Number of Well Records by Water Use

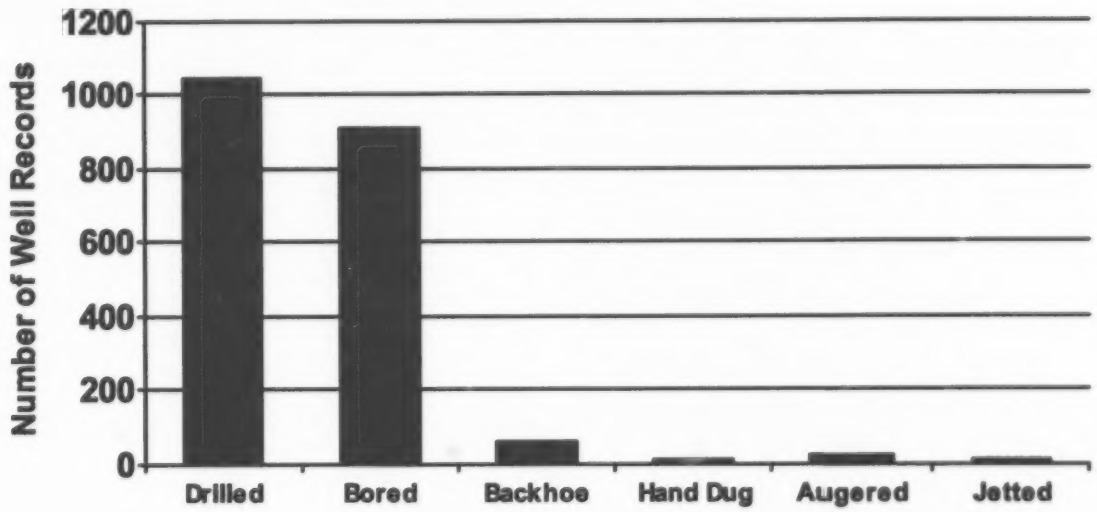

Figure 31: Number of Wells by Installation Method

4.4 Municipal Water Supply

4.4.1 Pipestone Creek Planning Unit

There are eight communities which source their water from within the Pipestone Creek Planning Unit as listed in Table 4. The surface water allocation to Grenfell of 253 dam^3 per year is tied to the Brown Hill Reservoir in the Qu'Appelle River basin, but partially supplied from water diverted from Pipestone Creek. The town of Kipling has two dams located south and south west of the town with combined allocations of 336 dam^3. As discussed in the 1992 Prairie Provinces Water Board Study, the water supply for Moosomin is from two wells located adjacent to Moosomin Reservoir. Given the proximity of the wells to the reservoir, that study assumed the wells were recharged exclusively from the reservoir in order to conservatively estimate surface water use in the Saskatchewan portion of the watershed. However, no hydrogeological assessment has been made of the connection between the reservoir and the two wells.

Community	Population (Government Relations Website)	Water Source	Average Annual Consumption (dam^3/year), trend	Average per capita consumption (lcpd, litres
Grenfell	1067	Pipestone Cr plus local runoff in Qu'Appelle Watershed	119 =	286
Kennedy	243	Groundwater	n/a	n/a
Kipling	1037	Local surface water plus ground water	151 =	386
Langbank	n/a (organized hamlet)	Ground water	n/a	n/a
Moosomin	2361	Ground water	439 =	470
Wapella	354	Ground water	59.5 -	382
Wawota	538	Ground water	64.9 -	292
Windthorst	228	Ground water	22.9 +	219
Totals	5828		856	403

= stable
- declining
+ increasing
n/a not available

Table 4: Municipal Supplies within the Pipestone Creek Watershed

4.4.2 Four Creeks Planning Unit

Currently there is no municipal water use for the Four Creeks Planning Unit.

4.4.3 Antler River Planning Unit

There are six communities that source their water from within the Antler River Planning Unit as listed in the following Table. The village of Manor straddles the watershed divide between Antler River and Moose Mountain Creek, however its municipal water source is from the Antler River Planning Unit.

Community	Population (GRAA Municipal Directory website)	Water Source	Average Annual Consumption (dam^3/year), trend	Average per capita consumption (lcpd)
Alida	117	Groundwater wells located adjacent to the Antler River	18.8 -	284
Carnduff	1017	Groundwater wells located adjacent to the Antler River	221 +	550
Glen Ewen	158	Groundwater	20.8 =	343
Manor	305	Groundwater wells located adjacent to a reservoir on Auburnton Creek	33.9 +	270
Redvers	917	Groundwater wells located adjacent to Redvers Reservoir on Lightning Creek	102 -	279
Totals	2,514		412	345

= stable
- declining
+ increasing

Table 5: Municipal Supplies within the Antler River Watershed

Glossary

Mean annual precipitation – average amount of snow and rain that falls in one year
Dam^3 – equal to .81066 acre-feet equal to 219,992 imperial gallons
Diversion – The removal of water from any water body, or watercourse, or aquifer (either for use or storage) and includes the removal of water for drainage purposes
Evaporation loss – a reduction of water by which water that returns to the air
Effective drainage – The area which is estimated to contribute runoff in at least one of two years
Non-effective drainage – The area which will contribute runoff only in high precipitation years
Gross drainage area – The area bounded by the height of land between adjacent watersheds
Ground water – Subsurface water usually in aquifers; water that occurs in voids or crevices of rock and soil
Recharge area – an area where water soaks through the earth to reach an aquifer
Lithology – The science that studies the nature and composition of stones and rocks

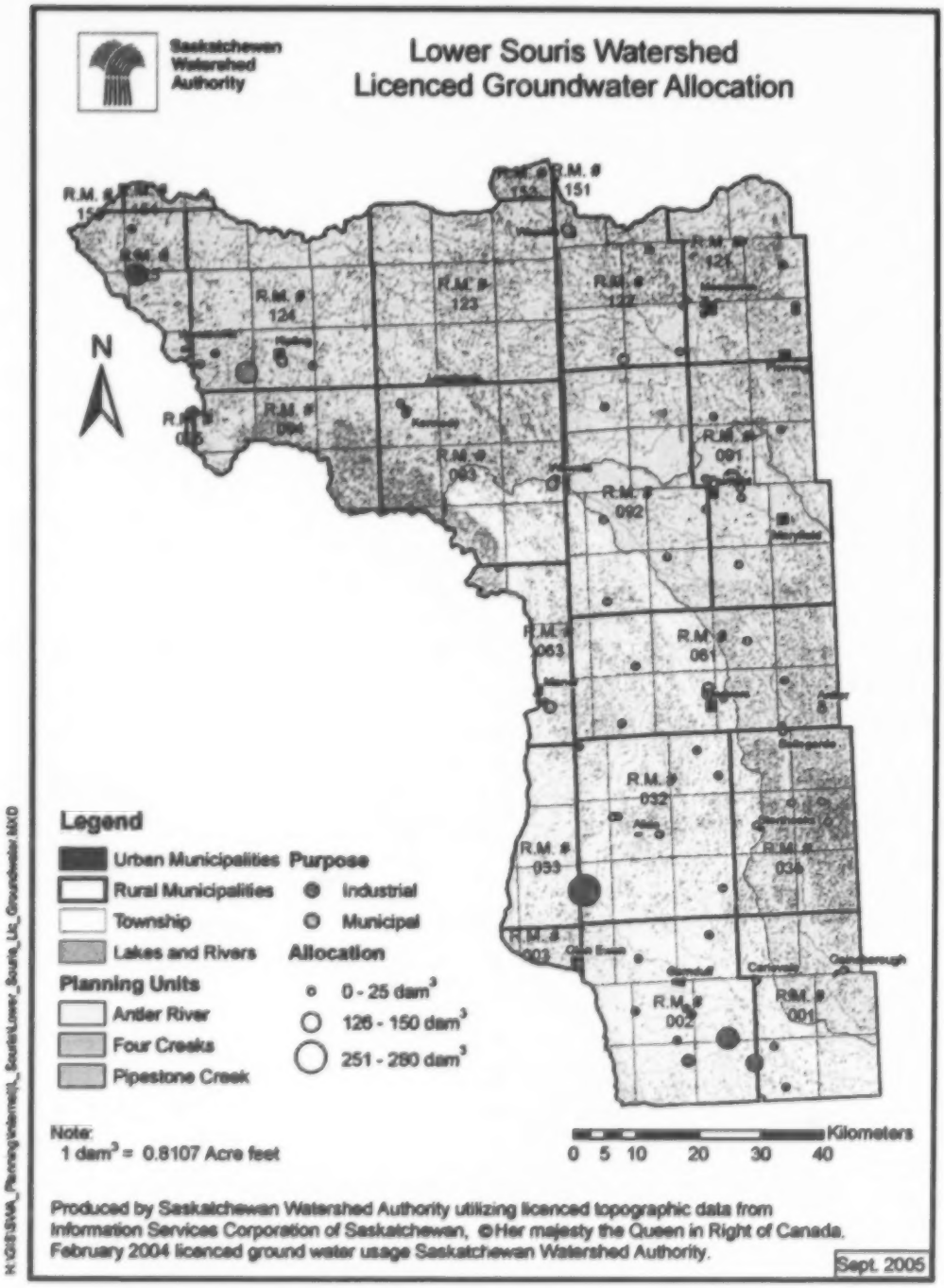

Figure 32: Licensed Groundwater Allocations

5.0 Water Management Interests

The Kingsley Conservation Area Authorities own and operate the Kipling Marsh flood control project. The project involves a number of ditches within the Kipling Marsh north of the Town of Kipling. These ditches lead to a pump station at the east side of the marsh. From there water is pumped out of the marsh, into a ditch through the natural divide and then flows to Pipestone Lake. Since the natural divide is about 6.7 metres above the marsh elevation, the marsh would not contribute to flows of Pipestone Creek under natural conditions. The 1992 Prairie Provinces Water Board Study estimated the long-term average increase in Pipestone Creek flow due to the Kipling Marsh Project to be 3,540 dam^3.

5.1 Intensive Livestock Operations

Saskatchewan Agriculture, Food and Rural Revitalization have a record of all the approved Intensive Livestock Operations in the Lower Souris River Watershed. This data base may include operations which were not built or have ceased to exist. It also does not have record of any operations that are registered or that were in existence prior to 1972.

5.2 Water Well Decommissioning

A well provides a direct conduit for contaminants to reach an aquifer, since a drilled or bored well bypasses the overlying protective sediment layers. The location of a well is an important consideration to ensure groundwater protection. Wells should be located away from water runs and all potential contaminants, and should not be located in low areas where surface water will pool. In cases where the well cannot be located on a well-drained site, upon completion the casing should be left several feet above the ground. The area around the casing should then be built up with clay or till and landscaped to ensure that water is diverted away from the casing and, therefore, does not have an opportunity to run down the side of the casing.

Courtesy: Saskatchewan Watershed Authority

Improper decommissioning (or abandonment) of wells will cause problems which include groundwater contamination, threats to public safety, damage to machinery, and increased liability. Emphasis on proper well decommissioning is critical in protecting water supplies. Decommissioning methods need to be tailored for each well, however, some general procedures to decommission wells can be provided by the Saskatchewan Watershed Authority. These include shock chlorination of the well, filling in the casing with clean chlorinated sand for large-diameter wells or pressurized bentonite slurry for small-diameter wells, excavating and removing the casing to below the water intake and frost line, capping with a six inch bentonite pad, and then backfilling and mounding with clay.

Courtesy: Saskatchewan Watershed Authority

The protection of groundwater aquifers is dependant upon the overlaying material. Because of fracturing, the permeability of glacial tills and clays will be higher in the top few metres. This allows contaminants to move quickly through this zone. With increasing depth, permeability rapidly decreases. Once a depth of 10 metres is reached, permeability in clays and tills become very low resulting in very slow contaminant movement. Contaminants will tend to flow vertically in low permeability materials. As well, the clays and till above an aquifer (or groundwater system) act to filter and remove contaminants and physically slow their movement. For example, clay is very effective at binding chemicals and organic matter through ion exchange and chemical bonding. While not nearly as effective as clay or till, sand will provide a limited buffer to help filter out contaminants. Aquifers overlain by sand and especially gravel must be regarded as very sensitive to groundwater contamination.

5.3 Water Conservation

The Government of Saskatchewan has made a commitment to develop a water conservation plan for Saskatchewan. The Saskatchewan Watershed Authority released a document entitled "*Conserving Our Water A Water Conservation Plan for Saskatchewan: a Discussion Guide for Public Consultation*" in January 2005.

5.4 Municipal Wastewater Treatment

Saskatchewan Environment is currently producing a provincial database for all of the communities operating a lagoon system. Figure 33 shows the current locations for community lagoons in the watershed licensed by Saskatchewan Environment.

5.5 Landfills

Courtesy: Saskatchewan Environment

Landfill near Moosomin

Landfills are considered potential areas where toxic substances may enter surface and groundwater source. Saskatchewan Environment has regulations within the Environmental Management and Protection Act to ensure municipalities dispose of refuse properly. All municipal landfills require a permit from Saskatchewan Environment. The application must ensure source water protection through the following regulation guidelines: the landfill ground is sloped for proper drainage; the location and depth of any well and the location of rivers, lakes, streams or other bodies of water within one kilometre of the proposed site is provided to Saskatchewan Environment; and the potential site's landscape, water table, surface water runoff and baseline ground water quality is provided to Saskatchewan Environment. Currently, the majority of landfills in Saskatchewan do not have valid operating permits. Figure 33 shows the location of landfills in the watershed base on data collected by Saskatchewan Environment in 1995.

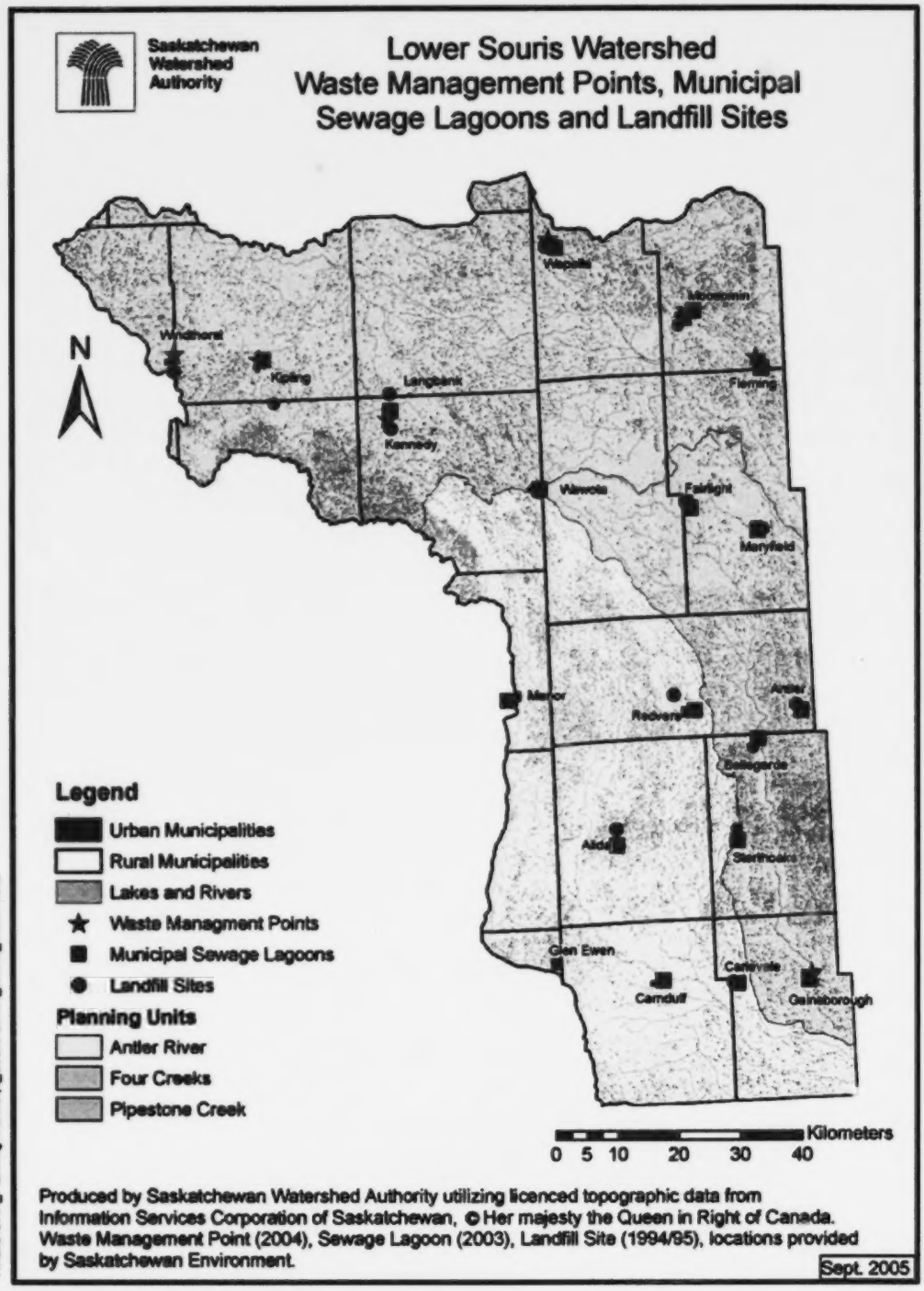
Saskatchewan Watershed Authority
Lower Souris Watershed
Waste Management Points, Municipal Sewage Lagoons and Landfill Sites
N
Legend
Urban Municipalities
Rural Municipalities
Lakes and Rivers
Waste Managment Points
Municipal Sewage Lagoons
Landfill Sites
Planning Units
Antler River
Four Creeks
Pipestone Creek
Kilometers
0 5 10 20 30 40
Produced by Saskatchewan Watershed Authority utilizing licenced topographic data from Information Services Corporation of Saskatchewan, © Her majesty the Queen in Right of Canada.
Waste Management Point (2004), Sewage Lagoon (2003), Landfill Site (1994/95), locations provided by Saskatchewan Environment.
Sept. 2005
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Figure 33: Waste Management Points, Municipal Sewage Lagoons and Landfills

5.6 Climate Change

Scientists around the world now recognize that the Earth's climate is changing – our world is getting warmer. Climate is naturally variable, and has changed greatly over the history of the Earth. Over the past two million years, the Earth's climate has alternated between ice ages and warm, interglacial periods. Climate on shorter time scales, too, changes continuously. For example, over the last 10, 000 years, most parts of Canada have experienced climate conditions that, at different times, were warmer, cooler, wetter and drier than experienced at present.

Extensive data demonstrates that the global climate has warmed during the past 150 years. This change was not a steady increase in temperature, but rather a series of warming and cooling cycles over intervals of several decades. The long-term trend, however, is one of net global warming. In tandem with this warming trend, alpine glaciers are retreating, sea levels are rising, and climatic zones are shifting. Changes in climate are expected to be variable across Canada, with the Arctic and the southern and central Prairies projected to warm the most.

Climate change is more than a warming trend. We can also expect changes in wind patterns, rain, and snow. Increases in the frequency of extreme climate events are one of the greatest concerns associated with climate change. Such extreme events include heat waves, droughts, floods and storms. In addition to the combination of factors involving industrialization and population growth, climate changes are and will place increased pressures upon water supplies and the accompanying supporting ecosystems in Canada.

The impacts of future global warming may change the prairie regional environment to a condition in which arid weather patterns persist for intervals of decades or longer. Climate change is generally expected to decrease the supply of water during the growing season, while concurrently increasing the demand. Seasonal changes in precipitation patterns are expected to be more important than changes in annual totals in terms of impact on human activities and ecosystems.

In all sectors, adaptation has the potential to reduce the magnitude of negative impacts and take advantage of possible benefits. Many of the commonly recommended adaptation options to address climate change in the water resources sector, including water conservation and preparedness for extreme events, are based on strategies for dealing with current climate variability. Structural adaptations, such as dams, weirs and drainage canals, tend to increase the flexibility of management operations, although they also incur economic, social and environmental costs.

Climate change forecasts and projections take a long term view. These trends are significant and irreversible, and require proactive and innovative public responses.

5.7 Wetland, Riparian and Upland Retention

Wetland Projects

Wetlands, riparian buffers and uplands are vital components of watersheds and are important in maintaining Saskatchewan's freshwater resource.

Courtesy: Saskatchewan Watershed Authority

The hydrological functions of wetlands include storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows and erosion prevention. Position in the landscape, location of the water table, soil permeability, slope, and moisture conditions all influence the ability of wetlands to ease floodwaters. Wetland drainage reduces the capability of a watershed to ease runoff during flood conditions and therefore increases the potential for flooding.

Recharge of ground water is an extremely important function of some wetlands; water filters slowly from wetlands to aquifers. Interactions between wetlands and local or regional ground water supplies are complex and site-specific and are affected by the position of the wetland with respect to ground water flow systems, geologic characteristics of the substrate, and climate.

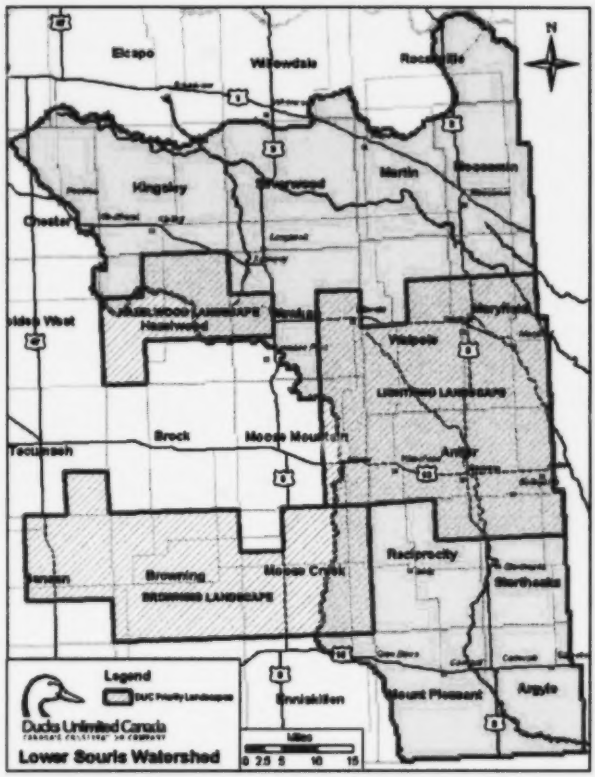
Wetlands are extremely complex systems and several characteristics contribute to their roles as nutrient sinks. They retain nutrients in buried sediments, convert non-living nutrients to organic biomass, and their shallow water depth maximizes water-soil contact and therefore microbial processing of nutrients and other material in the overlying waters. Wetlands can be effective in capturing nitrates in agricultural landscapes (over 80 percent removal). Phosphorus retention in wetlands can also be significant (up to 94 percent) and is accomplished by joining onto particles, precipitation with metals and incorporation into living biomass.

Wetlands can reduce the impacts of sedimentation on water quality within watersheds. Hydrology is a primary determinant of the sediment-retention capacity of a wetland and controls the source, amount, and spatial and temporal distribution of sediment inputs. Percent of wetland area and position are important for reducing sediment loads of water passing through the system.

Little information exists on the effects of the ability of natural wetlands to reduce microbial populations in water. The effectiveness of constructed wetlands to reduce pathogenic organisms from wastewater is high (up to 99 percent for coliforms). Natural wetlands are dominated by microbes (bacteria, fungi and algae) and plant life that are important for reducing pathogens.

High levels of biological productivity in wetlands result in dissipation of pesticides due to plentiful submersed and emergent plant growth that increases the availability of surface area for pesticides to be taken in and broken down by plants and small organisms.

In the early 1990's, Ducks Unlimited Canada went through a process of prioritizing the program delivery areas within the Prairies into landscapes. As part of this process, information available at the time was collected and summarized by landscape. Two of the landscapes fall within the Lower Souris River Watershed; the Lightning River landscape and the Hazelwood landscape.



The Lightning River landscape lies almost entirely in the central portion of the Lower Souris River Watershed spanning across both the Four Creeks and Antler Planning Units. The northeast half of the Hazelwood landscape falls in the Pipestone Planning Unit.

Lightning Creek Landscape

This landscape has one of the highest pothole densities in Saskatchewan. Larger wetlands are noticeably absent in the Lightning Creek landscape. Although a few wetlands are channel and terminal basin marshes, most are tall rush, deep marsh or tall grass shallow marsh wetlands where the water source is chiefly surface flow or ground water inflow. Most wetlands are fresh to moderately saline and support high proportions of emergent deep marsh interspersed with shallow open water.

According to the 1986 satellite habitat inventory, the Lightning Creek landscape has 46,798 wetlands totalling 70,094 acres with a pond density of two to 120 per square mile. Approximately 57 percent of the sections in this landscape ranked within the top three density and permanency ranges which consisted of 42 to 120 wetlands and five to 11 acres of permanent water per section.

Evaporation is considered moderate for this part of the province and pond loss from May to July is estimated at 50 percent.

Hazelwood Landscape

The wetlands throughout this landscape are classified by the Canadian Wetland Classification System as primarily kettle marsh with well defined edges and a fairly steep gradient from the edge to the deepest portion of the basin. The wetlands in the north-eastern parts of the landscape are more typical of shallow basin marsh wetlands with less

distinct catch basins. Water sources are local run-off with some limited ground water inflow. Very few wetlands in the landscape lie along streams with seasonal or ephemeral flow. In the western part of the landscape the relief increases and there are a number of larger, flat-bottomed wetlands that would be classified as permanent open water terminal basins.

According to the satellite habitat inventory, the Hazelwood landscape has 4,481 wetlands totalling 23,076 acres with a pond density of 0 to 42 per square mile. Approximately 47 percent (47 percent) of the sections with satellite coverage in this landscape ranked within the top three density and permanency ranges which consisted of ten to 42 wetlands and eight to 129 acres of permanent water per section. A total of 12 sections, or 4.7 percent of the area in the Hazelwood landscape had data unavailable.

Evaporation is considered moderate for this part of the province and pond loss from May to July is estimated at 50 percent.

Riparian Buffer Projects

Vegetated buffer strips can effectively control erosion and remove nutrients from surface water flow by forming a physical barrier that slows the surface flow of sediment and debris. The required width of a buffer size is determined by the type of vegetation present; the extent and impact of the adjacent land use; and the functional value of the receiving wetland. Studies have found the bulk of sediment removal occurs in the first few metres of the buffer zone; sediment removal can be 75 to 97 percent.

The main mechanisms of nitrate removal are by vegetation uptake in the roots and anaerobic microbial denitrification in the saturated zone of the soil. Relatively narrow buffers seem to be very effective in reducing nitrogen (35 to 96 percent).

Phosphorus retention can be effective (27 to 97 percent) in buffer strips that contain woody and non-woody vegetation, grasses and cropped buffer systems. Buffer strips can trap a significant proportion of pathogens (up to 74 percent of fecal coliforms). Low soil moisture and high soil temperature decrease survival of fecal coliform bacteria. The key process for pesticide retention in buffer strips is infiltration. Grass buffer strips can reduce pesticides by 80 to 100 percent.

Upland Cover Projects

Upland conservation programs, such as no till or permanent perennial cover and slow surface runoff, trap sediments and promote infiltration; consequently, these programs reduce the amount of sediments, nutrients and pesticides that enter the watershed.

The most beneficial outcome from implementing practices such as conservation tillage and permanent perennial cover is erosion reduction. Erosion from wind, rain and runoff can be reduced up to 99 percent because of greater site stability, infiltration and protection as a result of surface crop residue and perennial vegetation.

Upland cover has shown to be effective in reducing the amounts of nitrogen (up to 90 percent), phosphorus (up to 91 percent) and pesticides (up to 100 percent) in runoff, but there is potential for increased leaching through the soil profile to groundwater. Although

conservation tillage has not always reduced nutrient and pesticide leaching, this practice is recommended because the benefits outweigh the potential drawbacks. With respect to perennial upland cover, this land has been removed from production, resulting in fewer pesticides and fertilizer nutrients applied and subsequently released. Currently there is insufficient information regarding upland conservation practices and pathogen movement.

5.8 Drainage

There are five Conservation Area Authorities located either wholly or partially in the Lower Souris River Watershed. Three of the Conservation Area Authorities have projects that affect flows in Pipestone Creek. In addition, there are six authorized individual drainage projects and one highways project in the watershed.

Drainage projects in the Moosomin Reservoir area contribute an estimated 3,810 dam^3 of water annually. Highways project contributes 47 dam^3, Moosomin Conservation Area Authorities adds 223 dam^3 and the Kipling Marsh project, operated by the Kingsley Conservation Area Authorities, contributes a long term average of 3,540 dam^3 (based on early 1980's data).

The Silverwood Conservation Area Authority has a project which increases the effective drainage area into Pipestone Lake by 3.76 square kilometres. The 1992 Prairie Provinces Water Board Study estimated the long-term average increase in inflow to be 47 dam^3 per year. The Moosomin Conservation Area Authorities has a project which increases the effective drainage area to Pipestone Creek below Moosomin Reservoir by 11.1 km^2. The 1992 Prairie Provinces Water Board Study estimated the long-term average increase in streamflow volume to be 223 dam^3 per year.

A small area was drained in association with the construction of Highway #8 south of Moosomin in the mid-1950's. The increase in effective area into Moosomin Reservoir is 3.23 km^2. The 1992 Prairie Provinces Water Board Study estimated the long-term average increase in inflow to be 47 dam^3 per year.

The effect of the authorized individual drainage projects in the watershed and the effect of unauthorized projects have not been assessed. Studies of the effects of drainage in other watersheds have found that drainage projects increase runoff volumes in low and median runoff years but have a diminishing effect in increasingly higher runoff years.

6.0 Water Management, Agreement and Legislative Framework

6.1 Municipal Planning and Zoning Bylaws

Zoning bylaws contain zoning districts (agricultural or residential) and site regulations that may have regulations on the minimum area, site separate distances and permitted land uses. Policy plans contain statements on a wide variety of issues and may include restrictions on proximity of developments to water systems. There are two types of policy

plans, a development plan and a basic planning statement which is a simpler version of a development plan.

Figure 34 shows the current zoning policies implemented by the watersheds rural and urban municipalities.

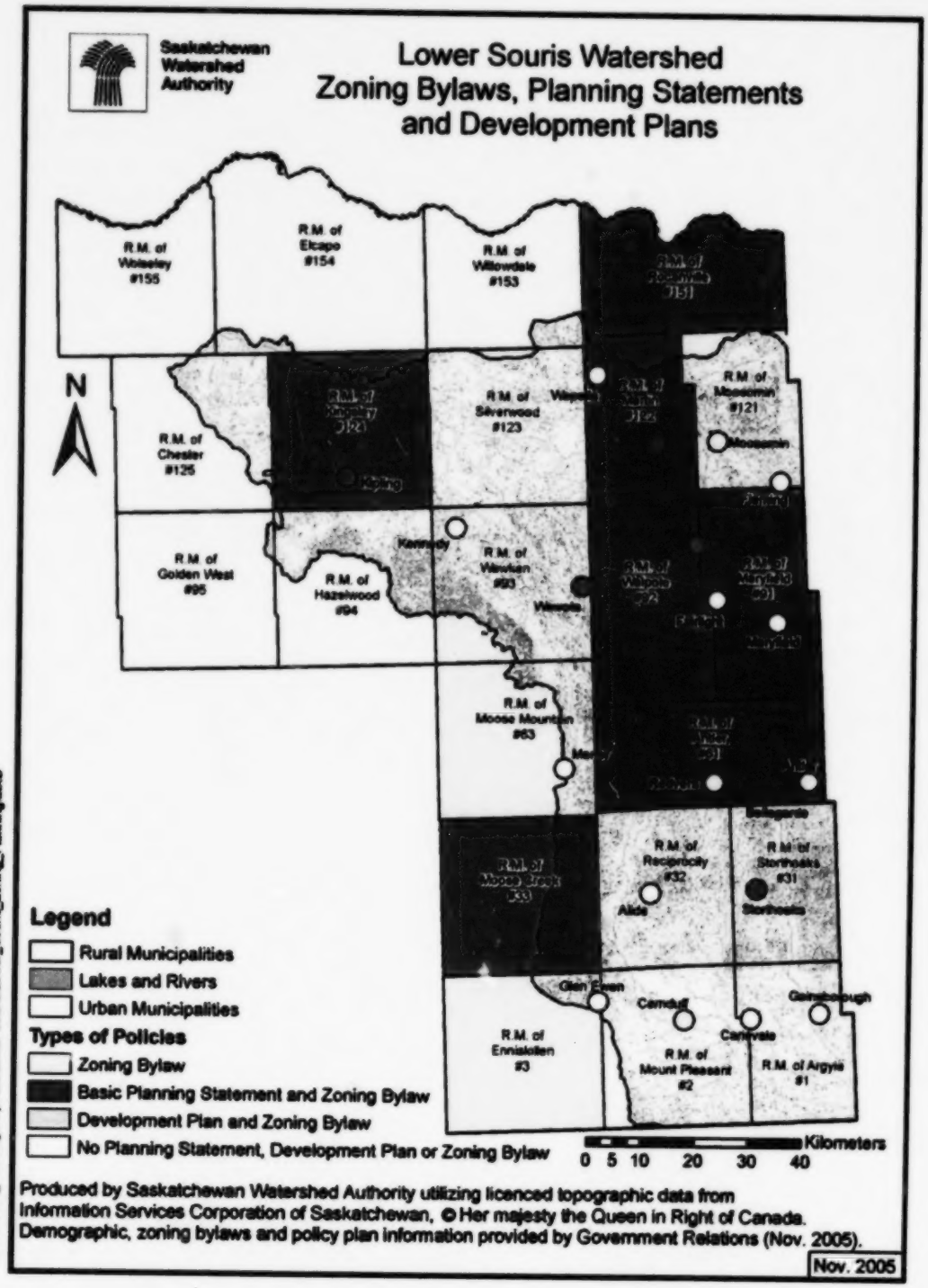


Figure 34: Zoning Bylaws, Planning Statements and Development Plans

6.2 Monitoring and Assessment

6.2.1 Saskatchewan Watershed Authority

Saskatchewan Watershed Authority currently monitors water quality in the Pipestone Creek basin in the Lower Souris River Watershed. Local concerns over water quality in Moosomin Reservoir led to the formation of a lake stewardship group that included local residents, stakeholders and the Saskatchewan Watershed Authority, previously Sask Water, in 2001. Since then, Saskatchewan Watershed Authority staff, with the assistance of the local stewards, has conducted annual sampling on the Reservoir. A water quality report of the results is produced by the Saskatchewan Watershed Authority each year.

Current sampling on Moosomin Reservoir involves a baseline site across from the store at Moosomin Regional Park along with two shoreline sites. Beginning in 2003, samples have been collected upstream of the Reservoir at 709 grid bridge on Pipestone Creek. In 2004 water quality was collected at two project and partnership stewardship projects on Pipestone Creek.

6.2.2 Fisheries and Oceans Canada

Alterations to streams and rivers such as culverts, diversions, dams and other barriers have changed the open access feature of these waterways and have taken their toll on our fishery resources. Improperly designed or damaged stream crossings are by far the most common cause of these problems.

In order to find these barriers, Fisheries and Oceans Canada completed an aerial survey of the Pipestone Creek in the spring of 2004. The aerial photography will help in assessing the fish habitat and identify areas were there is a blockage to fish passage.

6.2.3 Environment Canada

Environment Canada currently monitors stream flows in the Pipestone Creek at the border of Saskatchewan and Manitoba. Environment Canada has no water quality testing stations in the Lower Souris River Watershed at this time and has no plans to do a water management study in the watershed.

6.2.4 West Souris River Conservation District

Established in 1995, the West Souris River Conservation district has been working on soil and water conservation in the area. The West Souris River Conservation District is presently monitoring the water flowing into Manitoba from Saskatchewan on four tributaries: two locations on Pipestone Creek, and one location on each of the Jackson, Graham, Stony, Gainsborough and Antler water courses. Water samples consist of dissolved oxygen, phosphorous, dissolved minerals, fecal coliform bacteria, suspended sediment, trace elements and pesticides. For more information you can contact Glen Campbell at 204.877.3020.

6.3 Stewardship Programs & Available Funding

6.3.1 Ducks Unlimited Canada

Securement Method	Wetland		Upland		Total Acres
	# of Segments	Wetland Acres	# of Segments	Upland Acres	
Purchased Projects	11	520.3	20	2,318.9	2,839.2
Conservation Easement Projects	0	0	0	0	0
Leased Projects	11	460.9	23	1,895.0	2,355.9
Management Agreement Projects	38	830.1	66	5,153.0	5,983.1
Conservation Agreement Projects	49	2,093.8	7	105.6	2,199.4
Total	109	3,905.1	116	9,472.5	13,377.6
Securement Method	Wetland		Upland		Total Acres
	# of Segments	Wetland Acres	# of Segments	Upland Acres	
Purchased Projects	11	520.3	20	2,318.9	2,839.2
Conservation Easement Projects	0	0	0	0	0
Leased Projects	11	460.9	23	1,895.0	2,355.9
Management Agreement Projects	38	830.1	66	5,153.0	5,983.1
Conservation Agreement Projects	49	2,093.8	7	105.6	2,199.4
Total	109	3,905.1	116	9,472.5	13,377.6

Table 6: Lower Souris River Watershed - Ducks Unlimited Canada Project Summary

NOTE:
Each project may contain several segments (Minimum 2) (i.e. a single project will contain at least one wetland segment and one upland segment)
Each segment on a project includes one habitat type or program type.
A single project may contain more than one wetland or upland segment (i.e. Idled pasture and introduced grass would be two separate upland segments)

Purchased Projects

Purchased projects are lands purchased and owned by Ducks Unlimited Canada and managed for wildlife. Some purchased land is cost shared and held by Ducks Unlimited Canada and a partner including the Province's Fish and Wildlife Development Fund . The following programs were carried out on Ducks Unlimited Canada purchased properties: Idled pasture, protect native grass, planted dense nesting cover and protect small wetland/pothole complexes.

Properties purchased by Ducks Unlimited Canada are actively managed using techniques that will maximize wildlife benefits while maintaining grass stand vigour. Management of purchased lands occurs when deemed necessary by Ducks Unlimited Canada staff. Management such as haying or grazing is normally carried out by local producers through contracts under pre-established guidelines.

Conservation Easement Projects

A Conservation Easement is a voluntary legal agreement between a landowner and a government or qualified conservation organization, such as Ducks Unlimited Canada. A Conservation Easement is intended to preserve the natural integrity of the land by limiting the amount and type of development that can occur on a property in the future. Conservation Easement's are intended to secure and protect native pasture and protect small wetland/pothole complexes.

Conservation Easement's can be either paid or donated depending on financial implications. The Conservation Easement is registered on title and the term is perpetuity. The Conservation Easement can be one of two different types depending on the landowner's intentions for future use of the land and environmental benefits of each Conservation Easement.

Managed for Agriculture Conservation Easement's allow landowners to maintain agricultural uses of the land such as haying and grazing. However, agricultural uses shall not include any destructive activities such as breaking, cultivation, burning or conversion on these lands. The landowner remains responsible for and has sole discretion over management decisions on the land. Managed for Wildlife Conservation Easement's optimize the land's habitat quality for wildlife and waterfowl habitat by placing management decisions in the hands of the Conservation Easement holding agency (Ducks Unlimited Canada).

Leased Projects

Leased projects are lands leased by Ducks Unlimited Canada from the legal landowner and managed for wildlife. The following programs were carried out under lease agreements: Idled pasture, protect native grass, planted dense nesting cover and protect small wetland/pothole complexes

The lease agreement used to secure this habitat was signed between the legal landowner and Ducks Unlimited Canada. Lease terms were normally 10 years in length and the landowner retains title to land. The land being leased is idled but haying and grazing can be carried out by Ducks Unlimited Canada when required to manage the habitat.

Management Agreement Projects

Management Agreement Projects include Ducks Unlimited Canada's agricultural programs and any wetlands protected along with them. The following programs are completed using management agreements: Salinity program, grazing systems, convert to grazing system, deferred grazing native pasture, deferred tame forage, native prairie, convert to forage hay, winter wheat program and protect small wetland/pothole complexes.

Habitat was secured under these programs using a Management Agreement signed between the legal landowner and Ducks Unlimited Canada. Agreement terms vary from 7 to 21 years depending on the program type and ensure that the upland and wetland will remain for the term of the agreement. The landowner retains title to the land and agricultural practices may occur on the project in accordance with the agreement. The portion of the project cost picked up by Ducks Unlimited Canada varies with each different program.

Conservation Agreement Projects

Conservation Agreement Projects include all of Ducks Unlimited Canada's larger wetland projects constructed from 1938 to present and any associated upland areas secured as buffers around the large wetlands. They include the following securement types: Large wetlands (no control structure), water control structures, idled pasture.

These large wetland projects were secured using a Conservation Agreement signed between the legal landowner and Ducks Unlimited Canada. Agreement terms vary from 21 years to time without end depending on when the project was constructed and ensures that the wetland will remain and be managed for wildlife for the term of the agreement. The landowner retains title to the land and grants DUC the right to operate and manage the project. DUC is responsible for all costs associated with the installation and maintenance of any works within the project.

6.3.2 Saskatchewan Watershed Authority

The Saskatchewan Watershed Authority delivers stewardship programming in the Lower Souris River Watershed through the Prairie Stewardship Program. The goal of the Prairie Stewardship Program is to increase awareness of the importance, value, and function of riparian and native prairie ecosystems. Stewardship of these areas is encouraged through extension with landowners, government agencies, and other interested organizations. To participate in the program, landowners voluntarily conserve these areas through a verbal stewardship agreement. The land and all decisions on its management rest squarely in the hands of the individual landowner. Some voluntary stewards may also participate in demonstration projects that feature beneficial management practices. Healthy native prairie and riparian areas are essential components of healthy watersheds. Important components of the Prairie Stewardship Program include:

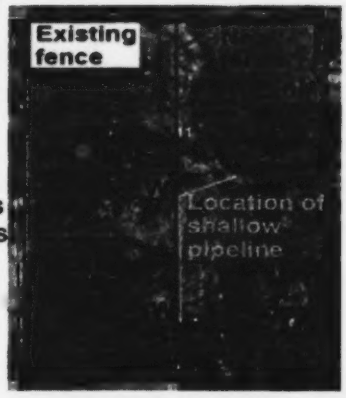
Voluntary Stewardship Agreement

As part of the Prairie Stewardship Program, landowners who wish to conserve a parcel of native prairie and/or a riparian area, may decide to enter into a voluntary stewardship agreement. Under such an agreement, landowners volunteer to:
Maintain and protect their native prairie and/or riparian areas to the best of their ability
While many landowners already practice good land stewardship, this agreement emphasizes the commitment of landowners to continue good management in the future.
Notify us of any planned land use change that might impact the native prairie and/or riparian areas
By contacting us before changing land management practices, landowners can access information on how to minimize any negative impacts on the site.

Notify us of any intent to sell or transfer ownership of the areas under the agreement. This will allow us to contact the new owner to offer information on the value of the natural habitat and discuss the stewardship program.
In the Lower Souris over 49 landowners have become voluntary stewards.

Demonstration Projects

Some of our voluntary stewards participate in demonstration projects that feature beneficial management practices that may involve cross fencing, remote watering systems, and/or tame pasture seeding. These win-win projects not only benefit habitat and wildlife, but they also help landowners to improve, or maintain the condition of their land. Benefits to the landowner may include an extended grazing season, or better water quality for livestock. Many of our demonstration projects are also designed to provide direct benefits to many of our endangered and threatened species. These projects are cost-shared 50-50 between the Saskatchewan Watershed Authority and the landowner. In the Lower Souris there are currently 23 grazing demonstration projects and 19 forage conversion projects.



On-Farm Planning

Planning is an important step in good stewardship. Participants in the voluntary stewardship program have access to resources to aid them in their on-farm planning. SWA stewardship staff can provide air photos, stocking tables and soil maps to help producers draw up pasture plans.

Range/Riparian Assessments

Formal condition assessments of range, pasture and riparian areas can be conducted for prairie stewards. This involves field work and a formal report to the producer on the state of their land and water resources. Many producers find that these assessments provide a valuable benchmark for monitoring management practices. These assessments can show the effectiveness of current management practices and can indicate if management changes are needed. Over 50 assessments have been conducted in the Lower Souris.

Range Schools

Range and pasture schools can be organized to provide voluntary stewards with hands-on training in range or riparian assessments. These intense workshops provide landowners with detailed information on plant identification, ecology and management of riparian and upland ecosystems. Many landowners enjoy learning to further 'read' the land they manage. Five Range schools have been held in the Lower Souris since 2002.

Field Tours

Field tours are organized to showcase the management efforts of landowners to peers and the general public. Stops at field tours may include visits to remote watering systems, cropland conversion sites, cross-fencing demonstrations, and more. Many field tours and workshops have been held in the Lower Souris.

Four Creeks Watershed Advisory Committee Inc.

In April 2004, the Four Creeks submitted a proposal to Greencover Canada to promote the adoption of Best Management Practices in the watershed. The accepted proposal allowed Four Creeks to hire a full time technician for a two year period to promote Best Management Practices in the Pipestone, Four Creeks and Antler River watersheds. To date, the Greencover proposal has been successful. Implementation of some Best Management Practices has already occurred. Ducks Unlimited Canada provided grass seed for buffer areas around wetlands and some cattle watering projects have been implemented through funding from Saskatchewan Watershed Authority Prairie Stewardship Program. One strength of the Greencover proposal has been the local support and implementation. Matching funds for the proposal were provided 12 rural municipalities who are located in the Pipestone, Four Creeks and Antler watersheds. Cooperative extension activities between Saskatchewan Watershed Authority and Four Creeks have led to many tours field days and land owner contacts.

In February 2005, Four Creeks began delivering a pilot Equivalent Agri- Environmental Planning (EAEP) process in the Lower Souris River Watershed. An Environmental Scan, Issue Identification and Implementation Strategy processes were developed. "Surface Water Quality" was identified as a priority issue to be identified addressed through the Equivalent Agri-Environmental Planning process. In June 2005, the first Action Plan was approved. The approved Action Plan allowed 39 producers to apply Best Management Practices under the Canada Saskatchewan Farm Stewardship Program to address surface water issues. Through 2006 and 2007, the Lower Souris Equivalent Agri- Environmental Planning expects another 100 producers to become involved in the Equivalent Agri- Environmental Planning process.

Distribution of Equivalent Agri- Environmental Planning projects throughout the Lower Souris River Watershed. White represents areas which are effectively drained

6.3.3 Saskatchewan Agriculture and Food

Saskatchewan Agriculture and Food cooperated with Manitoba and Alberta agriculture staff to develop a publication called "Tri-Provincial Manure Application and Use Guidelines" that presents an agronomic approach to the application of manure to land. Saskatchewan Agriculture and Food's Agricultural Operations Unit has developed site characterization guidelines to assist livestock developers in selecting suitable sites for earthen manure storage. Much of Saskatchewan is underlain by glacial till which is an effective material to securely contain manure. The guidelines will help identify locations with suitable material and sufficient separation from water sources to ensure protection of groundwater. The guidelines are based on a solute transport model developed by Dr. Lee Barbour of the University of Saskatchewan.

Saskatchewan Watershed Authority and Saskatchewan Agriculture and Food cooperated on the development of a publication titled *The Stewardship and Economics of Cattle Wintering Sites.*

Staff has also participated in the development of publications on animal mortality management and forage production with manure. Cooperation between the Western Beef Development Centre, Saskatchewan Agriculture and Food, the Saskatchewan Forage Council, the Prairie Farm Rehabilitation Administration and Ducks Unlimited resulted in the first annual Saskatchewan Pasture School – a hands-on, integrated learning workshop which combines classroom and field experience to teach Saskatchewan livestock and forage producers how to better manage their forage resource. Fifty-seven students participated in the first school. Saskatchewan Agriculture and Food along with other agencies participate on Saskatchewan Watershed Authority regional watershed planning committees to provide input into the environmental sustainability of development opportunities. Saskatchewan Agriculture and Food staff is involved in the implementation of a number of projects in the Lower Souris River Watershed as part of an Agro-Equivalent Environmental Farm Plan to improve environmental performance on farm.

6.3.4 Fisheries and Oceans Canada

Fisheries and Oceans Canada has contributed to the Four Creeks and Pipestone Creek Watershed Advisory Committees local newsletters. Future projects in the watershed will include cooperation between the Watershed Advisory Committees and Fisheries and Oceans Canada.

6.3.5 Agriculture and Agri-Food Canada

Prairie Farm Rehabilitation Administration has been assisting people for 70 years, helping them meet the challenges presented by a demanding climate and an ever-evolving agricultural industry. We serve over 30,000 clients annually, through ongoing programs and short-term initiatives offered from a network of district and regional offices and special Centres in the three Prairie provinces, and the Peace River region of British Columbia.

While we have adjusted our programs over time to remain relevant, our focus has been constant – to ensure the sustainable use of the Prairie's irreplaceable soil and water resources. Prairie Farm Rehabilitation Administration's activities complement and strengthen Agriculture and Agri-Food Canada's goals of sustainability and building a strong foundation for rural communities.

(http://www.agr.gc.ca/pfra/aboutus_e.htm)

The Prairie Farm Rehabilitation Administration Rural Water Development Program provided much needed financial and technical assistance to the development of individual, group and community water supply projects. Prairie Farm Rehabilitation Administration has also participated both financially and technically in numerous strategic studies related to water supply management. The assistance provided Rural Water Development Program to individual producers alone has had a profound effect on the landscape (Figure 35). This program provided funding in addition to various levels of technical assistance, to 5182 dugouts, 719 small diameter wells and 615 large diameter wells within the Lower Souris River Watershed Planning Area. The implementation of the Agricultural Policy Framework saw the Rural Water Development Program replaced by the Canada Saskatchewan Water Supply Expansion Program for the 2004/2005 fiscal year which began April 1, 2004. This program has been extended through 2008.

The AAFC-PFRA Shelterbelt Centre at Indian Head, Saskatchewan develops and distributed hardy plant materials for shelterbelts and diversification alternatives for its prairie clients. The Shelterbelt Centre also researches and promotes the beneficial environmental effects of shelterbelts. The AAFC-PFRA Agroforestry division, to which the shelterbelt centre belongs, distributes tree seedlings to agricultural producers and numerous agencies. These agencies include aboriginal bands, wildlife agencies, charitable organization, in addition to Federal, Provincial, and municipal agencies, as well as rural small land owners. The Agroforestry Division is implementing the Shelterbelt Enhancement Program. This program has made plastic mulch and mulch applicators available to increase the success of newly planted shelterbelts. Shelterbelt Centre trees planted in 2006 will be eligible for this program. During the period of 1994 to 2004, there were 1, 345, 276 tree seedlings delivered to rural clients in rural municipalities within or partially within the boundaries of the Lower Souris River Watershed Planning Area (Figures 36 and 37).

Converting annually cropped marginal lands to perennial forages has been accomplished by Permanent Cover Programs 1 and 2. Some of the benefits have been the reduction of soil erosion impacts on water quality, forage supplies for livestock, sequestration of the greenhouse gas carbon dioxide, and providing wildlife habitat. Within the Lower Souris River Watershed Planning Area, 3080 hectares of marginal land have been converted to perennial forages with the assistance of these two programs (Figure 38). Permanent Cover Program 1 was operated from 1987 to 1990. Permanent Cover Program 2 was operated from 1990 to 1995.

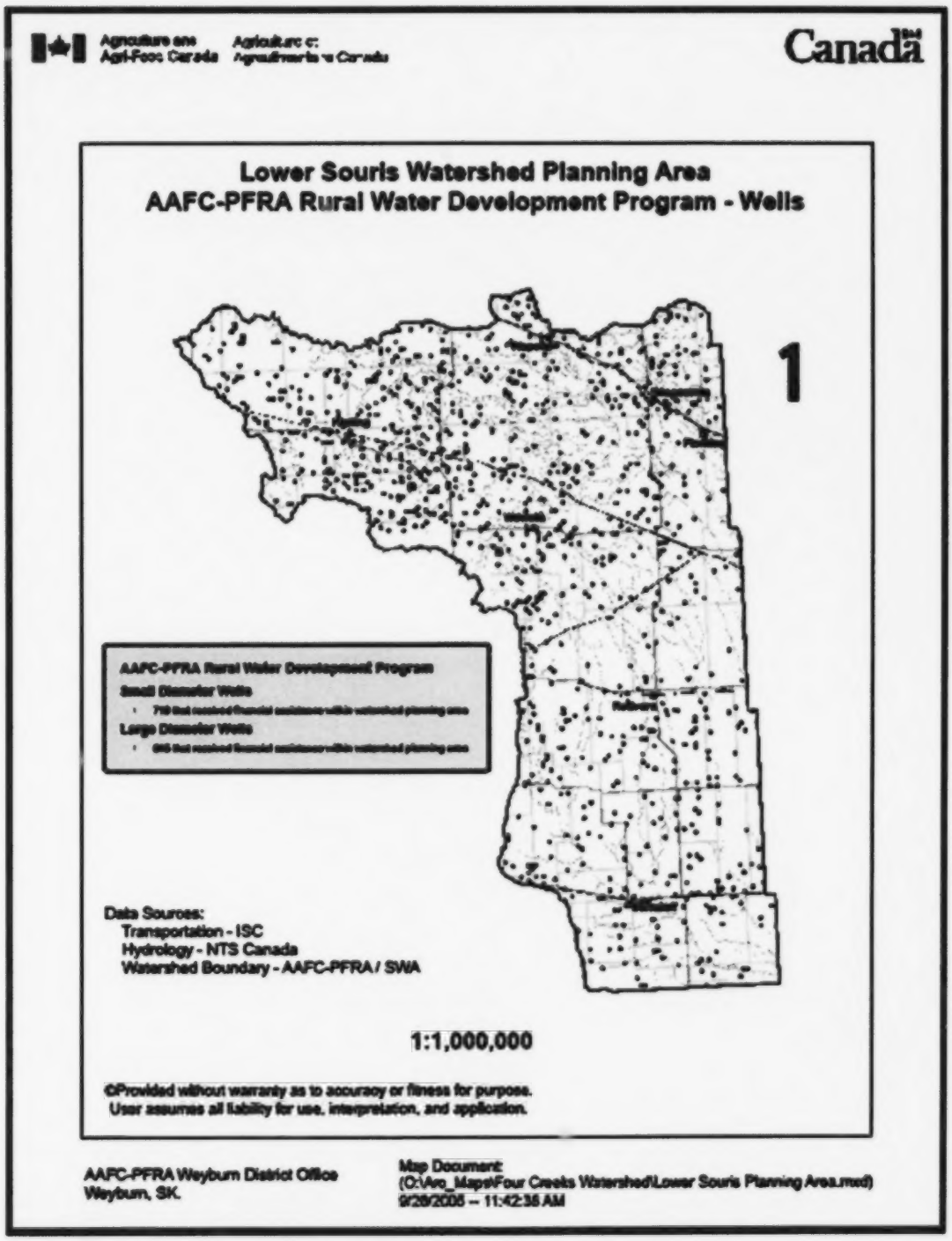
The Land Conversion Component of the Greencover Canada program continues to convert annually cropped marginal land to perennial cover. This program has been scheduled to run from 2003 to 2008 (Figure 39.

The Four Creeks Watershed Advisory Committee Inc. was approved for funding under the Greencover Canada Technical Assistance Component. This funding allowed the Four Creeks Watershed Advisory Committee Inc. to hire a Beneficial Management Practice technician for the Lower Souris River Watershed Planning Area.

The Environmental Farm Plan Program is a joint federal provincial stewardship program delivered by the Provincial Council of Agricultural, Development, and Diversification Boards. Participants in the program attend workshops to assess agri-environmental issues and risks on their farm. They then prepare an Environmental Farm Plan to address any problems identified by their assessment. Once producers have bone through the workshop and prepared their Environmental Farm Plan, they are then eligible for cost-shared funding under the National Farm Stewardship Program. This program provides 20 to 50 percent funding for 30 different Beneficial Management Practice categories.

The Lower Souris River Watershed was chosen as the pilot for the equivalent Agri-Environmental Plan portion of the National Farm Stewardship Program. Participants can apply through the Four Creeks Watershed Advisory Committee Inc. for funding for activities that fall under the Beneficial Management Practices categories of Wintering Site Management and Riparian Area Management. Forty producers were approved for the 2005/2006 fiscal year. Up to fifty producers per year can be approved for the next two years. Participants are not required to go through the Environmental Farm Plan process, but are limited to these two Beneficial Management Practice categories. The Equivalent program is intended to complement, not to compete with the Environmental Farm Plan program.

Prairie Farm Rehabilitation Administration started the Community Pasture Program in 1937. There are currently 62 Prairie Farm Rehabilitation Administration community pastures in Saskatchewan. However, none of these are located within the Lower Souris River Watershed Planning Area. Producers within this watershed can still apply to pasture their cattle at Prairie Farm Rehabilitation Administration pastures. The two closest Prairie Farm Rehabilitation Administration pastures are Coalfields Pasture in the Rural Municipality of Coalfields # 4 and Tecumseh Pasture in the Rural Municipality of Tecumseh # 65.


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Lower Souris Watershed Planning Area
AAFC-PFRA Rural Water Development Program - Wells
1
AAFC-PFRA Rural Water Development Program
Small Diameter Wells
Large Diameter Wells
Data Sources:
Transportation - ISC
Hydrology - NTS Canada
Watershed Boundary - AAFC-PFRA / SWA
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User assumes all liability for use, interpretation, and application.
AAFC-PFRA Weyburn District Office
Weyburn, SK.
Map Document:
(C:\Arc_Maps\Four Creeks Watershed\Lower Souris Planning Area.mxd)
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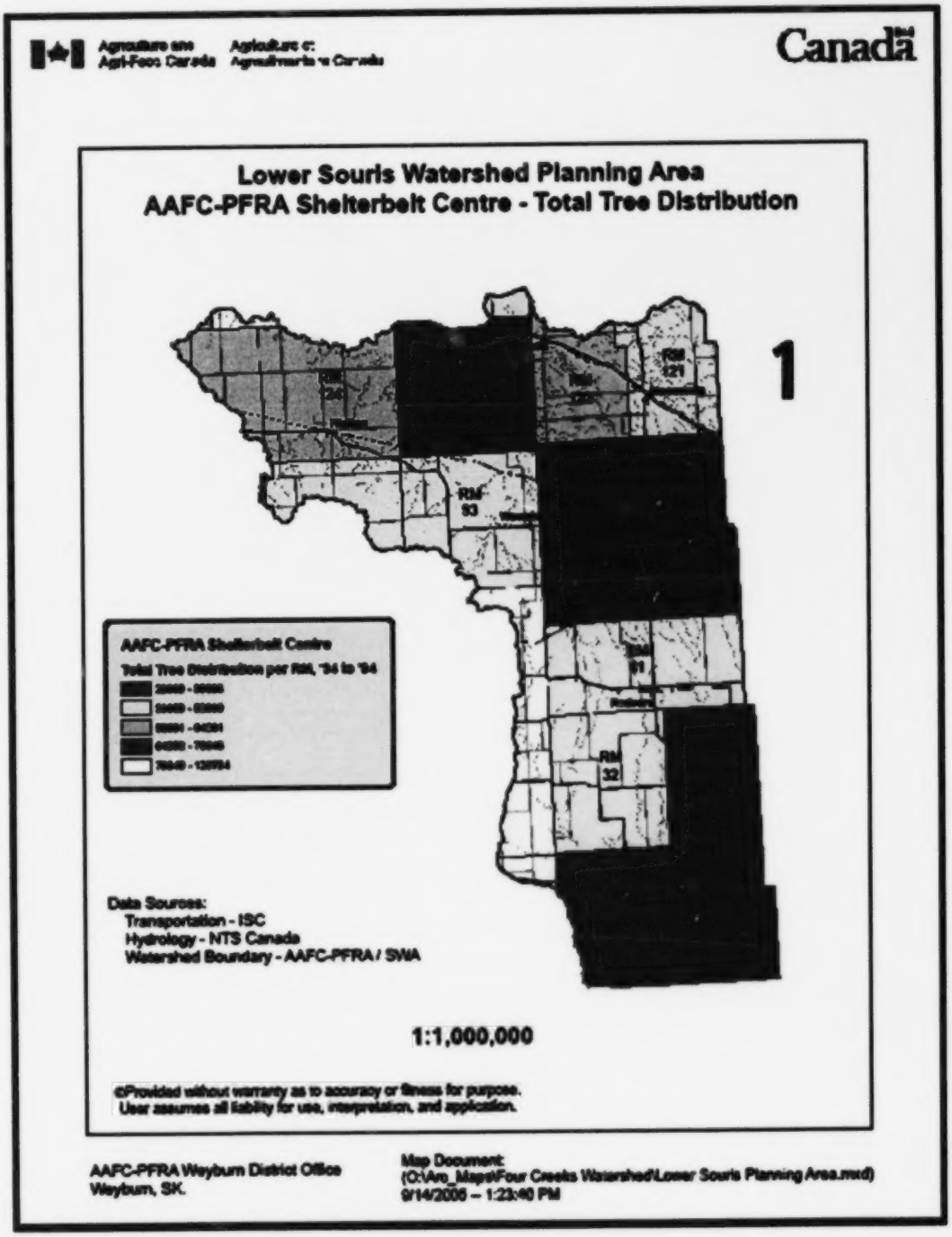
Figure 35: Lower Souris River Watershed Planning Area - Wells


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Lower Souris Watershed Planning Area
AAFC-PFRA Shelterbelt Centre - Total Tree Distribution
1
AAFC-PFRA Shelterbelt Centre
Total Tree Distribution per RM, '34 to '84
Data Sources:
Transportation - ISC
Hydrology - NTS Canada
Watershed Boundary - AAFC-PFRA / SWA
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AAFC-PFRA Weyburn District Office
Weyburn, SK.
Map Document:
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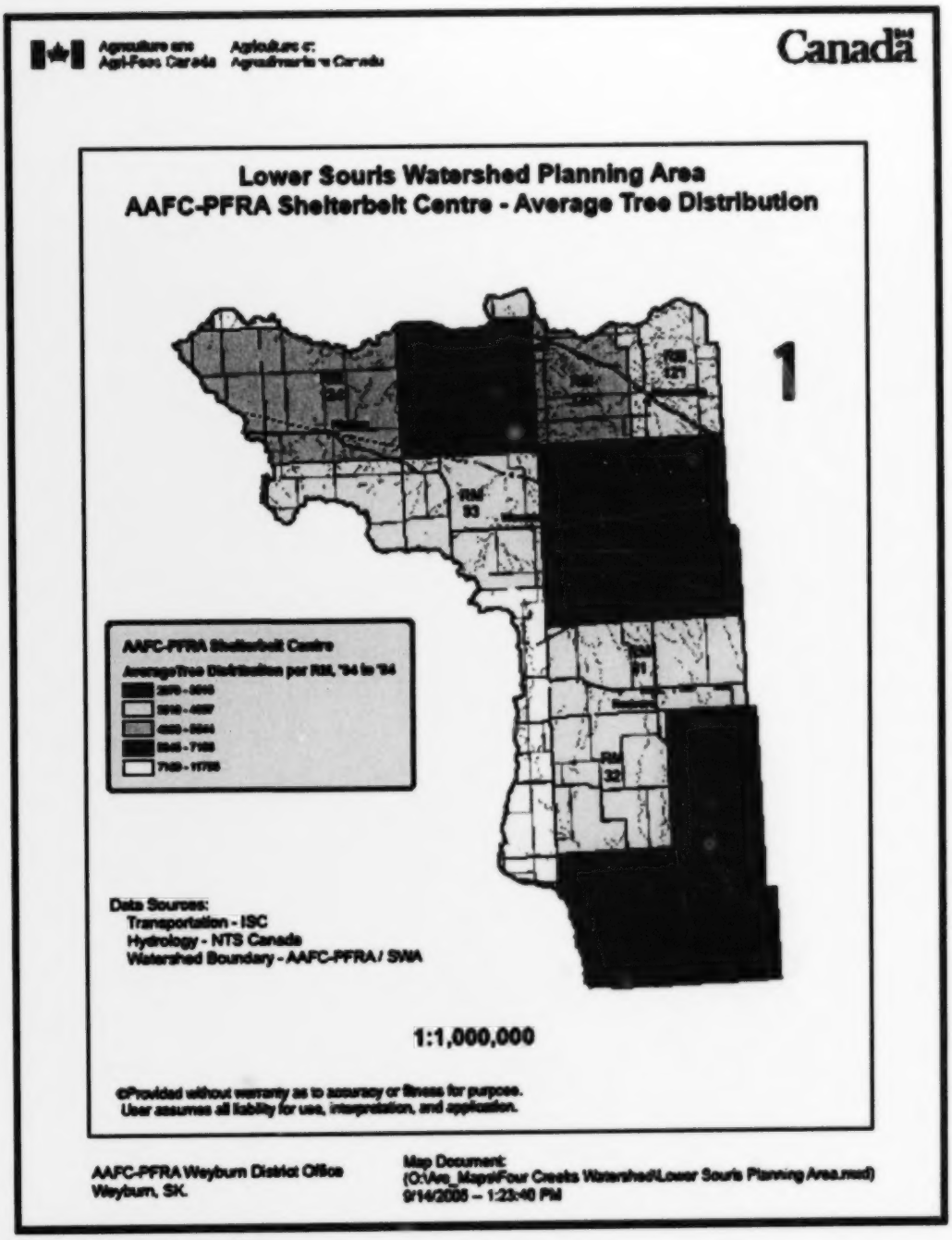
Figure 36: Lower Souris River Watershed Planning Area – Total Tree Distribution


Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Lower Souris Watershed Planning Area
AAFC-PFRA Shelterbelt Centre - Average Tree Distribution
1
RM 93
AAFC-PFRA Shelterbelt Centre
Data Sources:
Transportation - ISC
Hydrology - NTS Canada
Watershed Boundary - AAFC-PFRA / SWA
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User assumes all liability for use, interpretation, and application.
AAFC-PFRA Weyburn District Office
Weyburn, SK
Map Document:
(O:\Arc_Maps\Four Creeks Watershed\Lower Souris Planning Area.mxd)
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Figure 37: Lower Souris River

Conversion Table

Length

1.0 m	= 1.0 metre	1.0 km	= 1.0 kilometre
	= 3.28 feet		= 1,000 metre
	= 39.37 inches		= 0.621 miles

Area

1.0 m^2	= 1.0 square metre	1.0 km^2	= 1.0 square kilometre
	= 10.76 square feet		= 1.0 X 10^6 square metres
			= 0.386 square miles
			= 247 acres
			= 100 hectares

Volume

1.0 m^3	= 1.0 cubic metre	1.0 dam^3	= 1.0 cubic decametre
	= 35.31 cubic feet		= 1000 cubic metres
	= 220.083 imperial gallons		= 220,083 imperial gallons
	= 1,000 litres		= 0.810 acre feet
1.0 ig	= 1.0 imperial gallon	1.0 l	= 1.0 litre
	= 4.54 litres		= 0.221 imperial gallons
	= 0.00454 cubic metres		= 0.264 US gallons
	= 0.1605 cubic feet		= 0.001 cubic metres
			= 0.035 cubic feet

Rate

1.0 igpm	= 1.0 imperial gallon per minute	1.0 lps	= 1.0 litres per second
	= 0.833 US gallons per minute		= 13.22 imperial gallons per minute
	= 0.076 litres per second		= 11.01 US gallons per minute
	= 6.54 m^3/day		= 8.640 m^3/day
	= 1.94 acre feet/year		= 31.54 dam^3/year
	= 2.39 dam^3/year		
1.0 m^3/day	= 1.0 cubic metres per day	1.0 dam^3/day	
	= 220 imperial gallon per minute		= 1.0 cubic decametres per day
	= 0.0116 litres per second		= 1,000 cubic metres per year
	= 35.32 cubic feet per day		= 35,320 cubic feet per year

Glossary

Aquatic – consisting of, relating to or being in water; living or growing in, on or near water.

Aquifer – An underground layer of porous rock, sand or other material that allows movement of water between layers of non-porous rock or clay, usually restricted to water-bearing structures capable of yielding water in sufficient quantity to constitute a usable supply.

Base of Groundwater Exploration – A feature known as the base of groundwater exploration was established for the initial provincial groundwater maps and is shown on the cross section. Below the base of exploration, useable groundwater is either not present or is at too great of a depth to warrant drilling for small users.

Bedrock formations – Rock deposited prior to the glaciation. These layers are overlain by glacial deposits which consist of glacial till, sand and gravel.

Biodiversity – (Biological diversity) the many and varied species of life forms on earth, including plants, animals, micro-organisms, the genes they possess and their habitats.

Chernozemic soils – Fertile black soils rich in decaying plant material.

Climate – meteorological elements (e.g.: precipitation, temperature, radiation, wind, cloudiness) that characterize the average and extreme conditions of the atmosphere over long periods of time at a location or region of the earth's surface.

Climate change – an alteration in measured meteorological conditions that significantly differ from previous conditions and are seen to endure, bringing about corresponding changes in ecosystems and socio-economic activities.

Conservation – the preservation and renewal, when possible, of human and natural resources. The use, protection and improvement of natural resources according to principles that ensure their highest economic and social benefits.

Conservation easement – a legal agreement between a property owner and a conservation agency to restrict the type and amount of development on the owner's property.

Dam^3 - equal to .81066 acre-feet equal to 219,992 imperial gallons.

Development – building, engineering, mining or other operations that alter or intensify the use of a resource.

Discharge – the flow of surface water in a stream or ditch or the flow of groundwater from a spring or flowing artesian well; the rate of flow.

Drainage – movement of water off of land, either naturally or man-made.

*D*rought - generally in reference to periods of less than average or normal precipitation over a set time, sufficiently prolonged to cause serious hydrological imbalance that result in biological or economic losses.
*D*UC – Ducks Unlimited Canada, Inc., an entity that conserves, restores and manages wetlands and associated habitat for North American waterfowl.

Ecological – pertains to the relationship between living organisms and their environments.

*E*conomic development – the process of using and converting resources into wealth, jobs and an enhanced quality of life.

*E*coregion – An area characterized by its land forms, vegetation, climate and soils.

*E*cosystem – a dynamic complex of organisms (biota) including humans, and their physical environment, that interact as a functional unit in nature.

*E*ffective drainage area – the area which is estimated to contribute runoff in at least half of the years.

*E*vaporation loss - change of state from liquid to gas; ground seepage and evaporation are considered in calculating losses.

*E*xotic species – A living organism that is brought in from another area of the world.

First Nation – an Indian band or an Indian community functioning as a band but not having official band status, not including Inuit or Métis peoples.

Glacial Till – A mixture of clay, silt, sand, gravels and boulders varying in size and shape deposited by a glacier.

Gleysolic soils – Blue –grey, waterlogged soils.

Grazing management – activities that ensure stocking rates are appropriate to sustain long-term health of livestock grazing conditions during wet and dry seasons.

Gross drainage area – The area bounded by the height of land between adjacent watersheds.

Groundwater – subsurface water usually in aquifers; water that occurs in voids or crevices of rock and soil.

Habitat – natural surroundings or native environment where a plant or animal grows and lives.

*H*eadwater – small streams and lakes that are the sources of a river, located in the upper reaches of a watershed.

*H*ydro – from Greek *hydor*, meaning "water."

*H*ydrogeology – the science of subsurface waters and related geologic aspects.

*H*ydrology – the science of the waters of the earth, their occurrences, circulation and distribution on or below the earth's surface.

Intensive Livestock Operation (ILO) - production facilities such as feedlots and buildings where many animals are raised in a confined space that does not have naturally-growing vegetation and where waste accumulates if not removed (as defined by The Agricultural Operations Act in Saskatchewan).

Land cover – predominant vegetation on the surface of a parcel of land.
*L*and use – present use of a given area of land.

*L*oamy soils – Fertile clay and sand soils with decaying plant material.

Median – a value in a sorted range of values by which there is the same number of values above it as there is below it. A statistical term used in non parametric statistics.

Native prairie – age-old plant communities of the prairie and parkland regions that may contain more than 200 types of grasses, flowers and shrubs (native grassland and parkland aquatic and terrestrial habitats)

*N*on-point source pollution – single or multiple contaminants of unknown origin that enter waterways, degrading water quality.

Partnership – co-operative, collaborative alliance between/among stakeholders in a non-legal arrangement used to improve and build relationships and achieve common goals.

*P*oint source contamination – a static and easily identifiable source of air, soil or water pollution.

Recharge area - A collective surface area that allows for water to seep in to the ground.

*R*iparian - An area of vegetation (i.e.: willows, cattails) that interact with bodies of water (i.e. wetlands, rivers, lakes).

*R*iparian areas – the zone of vegetation alongside waterways and other surface water. Lush and diverse vegetation is the best sign of healthy, well-managed riparian areas and is critical to filtering and slowing runoff.

*R*iver basin – an area that contributes to form a watershed. (See watershed)

Sewage – the waste and wastewater from residential or commercial establishments that are normally discharged into sewers.

*S*ewage lagoon – a shallow pond where sunlight, bacterial action and oxygen work to purify wastewater; also used for storage of wastewater.

*S*ource water protection – the prevention of pollution and the sound management of factors and activities that (may) threaten water quality and quantity of lakes, reservoirs, rivers, streams and groundwater.

*S*takeholder – individual or group with direct or indirect interest in issues or situations, usually involved in understanding and helping resolve or improve their situations.

*S*tewardship – judicious care and responsibility by individuals or institutions for reducing their impacts on the natural environment.

Water quality – the chemical, physical and biological characteristics of water with respect to its suitability for a specific use.

*W*atershed – an elevated boundary contained by its drainage divide and subject to surface and subsurface drainage under gravity to the ocean or interior lakes.

*W*atershed health – the desired maintenance over time of biological diversity, biotic integrity and ecological processes of a watershed.

*W*atershed and aquifer management – a process, within the geographic confines of a watershed or aquifer, that facilitates planning, directing, monitoring and evaluating activities to ensure sustainable, reliable, safe and clean water supplies.

*W*atershed and aquifer planning – A process, within the geographic confines of a watershed or aquifer and with the participation of stakeholders, to develop plans to manage and protect water resources.

*W*etland – an area of low-lying land covered by water often enough to support aquatic plants and wildlife for part of the life cycle. The wetland area includes the wet basin and adjacent upland.

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Appendices

Appendix 1

Lower Souris River Watershed Technical Committee

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Appendix 2

Overview of the Hydrology of the Eastern Souris Tributaries in Saskatchewan

Drainage Areas

There are a number of streams which flow eastward out of Saskatchewan to join the Souris River in Manitoba. Four of these, Stony, Jackson, Graham, and Gainsborough creeks are the subject of the Eastern Souris Tributaries Watershed Plan.

Drainage areas for Jackson, Graham, a nd Gainsborough creeks are given in a series of reports prepared for the PPWB between 1981 and 1987. Drainage areas for Stony Creek were taken from 1:50,000 topographic maps showing the accepted drainage areas as were total tributary area in Saskatchewan for Graham and Gainsborough creeks. There is a small wedge of gross drainage area between Graham and Gainsborough creeks that is tributary directly to the Souris River.

Stream	Area Tributary to last border crossing			Total tributary area in Saskatchewan		
	Gross (km^2)	Effective (km^2)	E/G (%)	Gross (km^2)	Effective (km^2)	E/G (%)
Stony	114.9	61.2	53	143.7	71.1	49
Jackson	162.8	62.2	38	172.7	63.2	37
Graham	264	51.3	19	430	42.7	10
Souris				21.2	0	0
Gainsborough	1,063	519	49	1,151	523	45
Total				1,920	700	

(A review of the non-effective headwater areas of Stony and Jackson creeks in Twp 11, Range 32 is recommended. SWA Basin Operations staff, in reviewing drainage areas for a local peak potential study early in 2002, concluded that the outflow from the McCannell DU project in section 23 outflows to the Kennedy projects in sections 25 and 36, which in turn outflow to the Little Pipestone Creek. Current drainage area maps show the McCannell project as tributary to Jackson Creek. A task group comprised of Bart Oegema (SWA), Jim Yarotski (PFRA), and Brad Uhrich (DU) should be formed to investigate this issue. Changes to the drainage boundary, if recommended, should first be reviewed and approved by the PPWB Committee on Hydrology before the PFRA drainage area database is amended.)

Gross drainage areas in each province are compared in the following table.

Stream	Gross Area (km^2)			Percent of total (%)	
	SK	Man	Total	SK	Man
Stony	144	1,108	1,252	12	88
Jackson	173	339	512	34	66
Graham	430	301	731	59	41
Gainsborough	1,151	316	1,467	78	22

Effective drainage areas in each province are compared in the following table.

Stream	Effective Area (km^2)			Percent of total (%)	
	SK	Man	Total	SK	Man
Stony	71	301	372	19	81
Jackson	63	157	220	29	71
Graham	43	136	179	24	76
Gainsborough	523	124	647	81	19

An interesting note from these two tables is an almost inverse relationship in watershed size between the two provinces; at the north end of the study area Stony Creek has the smallest Saskatchewan area but the largest Manitoba area, while in the south Gainsborough has the largest Saskatchewan area but the smallest Manitoba area.

Previous Studies

Studies of the hydrology of Jackson, Graham, and Gainsborough creeks have been carried out on behalf of the PPWB Committee on Hydrology. A similar study was not done for Stony Creek, likely due to its small drainage area and the absence of any water uses in the Saskatchewan portion of the watershed at the time.

Jackson Creek

Using a 72-year study period (1912-83), the average annual natural flow volume of Jackson Creek at the Saskatchewan-Manitoba boundary was found to be 1,130 dam^3. The median annual flow volume was found to be 276 dam^3, and the average annual use was estimated to be 108 dam^3. Over the 72-year period, current uses (as of 1986) would have exceeded Saskatchewan's 50 percent share of the natural flow in 29 years. Based on these results, the

report recommended that water use and levels at Maryfield Reservoir be monitored, and that a streamflow station be established on Jackson Creek near the Saskatchewan-Manitoba boundary.

Graham Creek

Using a 68-year study period (1912-79), the average annual natural flow volume of Graham Creek at the Saskatchewan-Manitoba boundary was found to be 813 dam^3. The median annual flow volume was found to be 330 dam^3, and the average annual use was estimated to be 23 dam^3. Over the 68-year period, current uses (as of 1979) would not have exceeded Saskatchewan's 50 percent share of the natural flow. The report recommended that consideration be given to establishing a streamflow station be established on Graham Creek near the Saskatchewan-Manitoba boundary as the station near Melita was felt to provide questionable representation of flows at the interprovincial boundary as the effective area at the boundary is only 29 percent of the gauged effective area.

Gainsborough Creek

Using a 67-year study period (1912-78), the average annual natural flow volume of Gainsborough Creek at the Saskatchewan-Manitoba boundary was found to be 8,420 dam^3. The median annual flow volume was found to be 3,350 dam^3, and the average annual use was estimated to be 611 dam^3. Over the 67-year period, current uses (as of 1979) would have exceeded Saskatchewan's 50 percent share of the natural flow in 22 years. However, simulations indicated that in 16 of the 22 years, the shortage to Manitoba could be eliminated by releases of water from the Gainsborough Community Project. The report indicated that the existing streamflow station near Lyleton was adequate for monitoring apportionment of flow on Gainsborough Creek, but recommended that water levels on the Gainsborough Community Project be monitored to more accurately assess water use at the project.

Runoff Characteristics

Each of the four streams are classified as intermittent, meaning there is typically some flow during spring snowmelt followed by zero or near-zero flows through the late spring, summer, fall and winter, interrupted only occasionally by rainfall runoff in the event of a very high rainfall amounts.

Median unit runoff is a measure that characterizes the typical runoff from an area. It is calculated by dividing the median runoff at a given location by the effective drainage area to that location. The units for unit runoff are dam^3/km^2 or millimetres. Using the results of the three PPWB studies, the median runoff for Jackson, Graham, and Gainsborough creeks at their interprovincial boundary crossings are 4.4 mm, 6.4 mm, and 6.5 mm respectively. This compares with mean annual precipitation of 460 mm to 490 mm (Yarotski, 2002).

Another source of median unit runoff estimates is a 1994 study by PFRA which examined flows from numerous streamflow stations across prairie Canada and mapped unit runoff. The resulting maps show the study area to be located in an area where median unit runoff is less than 10 mm. The pocket of low runoff extends only a short distance into Manitoba and represents the lowest median unit runoff in that entire province. The map also shows that median unit runoff of 10 mm or less is more typical of the western and central grainbelt of Saskatchewan and of most of southern Alberta.

Water Use and Availability

Stony Creek

Assuming a median unit runoff equal to that in Jackson Creek of 4.4 mm, the median annual natural runoff volume of Stony Creek at the boundary crossing is 270 dam^3. There is only one authorized water use project in the Saskatchewan portion of the watershed. Pertinent details are listed below:

Stony Creek Water Allocations

WR #	Land Location	Purpose	Project	Year Authorized	Allocation (dam^3)
15162	SE18-11-30-1	other	DU Flynn	1987	64

With an allocation of 64 dam^3, the DU project water use represents about 24 percent of the estimated median annual natural flow of Stony Creek at the boundary crossing.

Jackson Creek

There are currently five authorized projects in the effective portion of the Jackson Creek drainage area. In addition there are two projects in the non-effective portion to the drainage area. All seven projects are listed below, together with an unauthorized project listed in the 1987 PPWB report.

Jackson Creek Water Allocations

WR #	Land Location	Purpose	Project	Year Authorized	Allocation (dam^3)
In effective area					
418	SE18-10-30-1	mun	Maryfield Reservoir	1923	84
2126	NW33-9-30-1	dom		1938	2
3091	NE5-10-30-1	dom		1960	9
8750	SE2-9-30-1	dom		1961	5
13987	SE22-9-30-1	dom		1980	5
n/a	NW8-10-30-1	dom	unauthorized listed in PPWB		3
					108
In non-effective area					
2896	SW29-9-30-1	dom		1938	5
13581	SW23-11-32-1	other	DU McCannell Project	1979	53
					58

The total estimated use within the Jackson Creek effective area remains unchanged from the 1987 PPWB study. With an estimated median annual natural flow volume of 276 dam^3, the estimated use represents nearly 40 percent of the natural flow volume. However, the estimated use at Maryfield Reservoir needs closer examination. Reported water use by the community has varied between 38.3 dam^3 and 44.5 dam^3 from 1990 to 2001. The Village Administrator reports that since 1991 all the municipal water use is sourced from the Village well. Thus, the allocation from the reservoir based on use of 52 dam^3 and evaporation loss of 32 dam^3 is not accurate and neither is the estimated basin water use of 108 dam^3.

Graham Creek

There are currently three authorized projects in the effective portion of the Graham Creek drainage area. In addition there is one project in the non-effective portion to the drainage area.

All four projects are listed below, together with an unauthorized project listed in the 1981 PPWB report.

Graham Creek Water Allocations

WR #	Land Location	Purpose	Project	Year Authorized	Allocation (dam^3)
In effective area					
1440	SE34-8-30-1	dom		1937	12
3819	NW14-8-30-1	dom		1943	2
3844	SW23-8-30-1	dom		1940	5
n/a	SE11-8-30-1	flood control	unauthorized listed in PPWB		1
					20
In non-effective area					
14134	NW11-7-30-1	mun	Antler Community Dugout	1981	7

The total estimated use within the Graham Creek effective area is down slightly from the 23 dam^3 listed in the 1981 PPWB study. With an estimated median annual natural flow volume of 330 dam^3, the estimated use represents only six percent of the median annual natural flow volume.

Gainsborough Creek

There are currently 15 authorized projects in the effective portion of the Gainsborough Creek drainage area. In addition there is one project in the non-effective portion to the drainage area. All 16 projects are listed below, together with seven unauthorized projects listed in the 1987 PPWB report.

Gainsborough Creek Water Allocations

WR #	Land Location	Purpose	Project	Year Authorized	Allocation (dam3)
In effective area					
257	NW18-7-30-1	indust	CPR dam	1915	24
2940	NW6-8-30-1	dom		1943	50
3646	SE32-10-32-1	dom		1940	7
3675	NE15-8-31-1	dom		1940	5
9501	NE2-2-30-1	mun	Gainsborough Community Project	1976	245
11730	NW18-8-30-1	dom		1971	6
12087	SW33-10-32-1	other	DU Melenchuk	1974	27
12321	NE28-10-32-1	other	DU Melenchuk-DeRoo	1976	15
13580	SE11-10-33-1	other	DU Eisler	1983	32
13632	SE3-11-32-1	other	DU Colborn	1981	38
13641	NW2-2-30-1	irr		1980	32
13693	NW3-10-31-1	dom		1979	4
13701	NE2-2-30-1	irr		1980	156
15881	SE23-7-31	dom		1990	11
16337	NE1-6-31-1	dom		1992	9
n/a	SW5-10-31-1		unauthorized listed in PPWB		3.7
n/a	NW31-9-32-1		unauthorized listed in PPWB		6.2
n/a	SE34-10-32-1		unauthorized listed in PPWB		3.7
n/a	SW6-10-31-1		unauthorized listed in PPWB		2.5
n/a	NW4-9-31-1		unauthorized listed in PPWB		4.9
n/a	NE31-10-33-1		unauthorized listed in PPWB		4.9
n/a	NE4-10-31-1		unauthorized listed in PPWB		1.2
					688
In non-effective area					
11038	NE25-9-32-1	irr		1970	5

The total estimated use within the Gainsborough Creek effective area is up from the estimated annual use of 611 dam^3 in the 1987 PPWB study. With an estimated median annual natural flow volume of 3,350 dam^3, the estimated current use represents 21 percent of the median annual natural flow volume.

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Yarotski, 2002 Personal communication.

Appendix 3

Overview of the hydrology of the Pipestone Creek in Eastern Saskatchewan

Drainage Areas

There are a number of streams which flow eastward out of Saskatchewan to join the Souris River in Manitoba. One of these is the Pipestone Creek.

The gross and effective drainage areas for Pipestone Creek at the Saskatchewan Manitoba boundary are 3,900 km^2 and 1,181 km^2 respectively (PFRA, July 2003). This includes the non-effective headwater areas in Twp 11, Range 32 containing the McCannell DU project in section 23 and the DU Kennedy projects in sections 25 and 36. Previous drainage area maps had shown the McCannell project as tributary to Jackson Creek.

Previous Hydrology Studies

The hydrology of the Pipestone Creek watershed in Saskatchewan has been the subject of two studies carried out on behalf of the PPWB Committee on Hydrology, which will be summarized here. Additional hydrology studies have been conducted for various projects in the watershed which will be discussed in the water use portion of this report.

1979 Natural Flow Study (PPWB, 1979)

Using a 66-year study period (1912-77), the average annual natural flow volume of Pipestone Creek at the Saskatchewan-Manitoba boundary was found to be 35,660 dam^3. The median annual flow volume was found to be 25,560 dam^3. The natural flow study considered the effects of some 38 water use projects, including Pipestone Lake and Moosomin Reservoir. In addition, the study considered the effect on natural flows of the Kipling Marsh Drainage Project. The study found that on average, the volume of water added to the system from Kipling Marsh exceeded the consumptive use of all other projects in the watershed. However, since consumption would continue in drier years, while pumping from the Marsh would not, there could be instances of apportionment shortfall to Manitoba if specific releases were not made from Moosomin Reservoir to ensure Manitoba received its entitlement of fifty percent of the annual natural flow volume.

1992 Natural Flow Study (PPWB, 1992)

The 1992 study used a shorter study starting in 1943 when the first flow records anywhere on Pipestone Creek were collected. Somewhat different methodologies and databases were employed yielding an average annual natural flow volume of Pipestone Creek at the Saskatchewan-Manitoba boundary of 43,200 dam^3 for the period 1944-88. The median annual flow volume was found to be 29,400 dam^3. A total of 49 water use projects in the effective drainage area of Pipestone Creek were considered in this study. In addition to explicitly

considering the effects of Pipestone Lake, Moosomin Reservoir, and the Kipling Marsh, several other water use and drainage projects were modelled. These included the Grenfell Diversion, an irrigation project, three authorized drainage projects, and Moosomin municipal withdrawal from Moosomin Reservoir (although technically a groundwater allocation).

Basin Hydrologic and Runoff Characteristics

The mean annual precipitation for the Pipestone Creek watershed varies from about 415 mm near Broadview to about 460 mm at Kipling to about 510 mm at Moosomin (Environment Canada). If the average precipitation over the whole watershed is assumed to be 460 mm, then the average volume of water received by the watershed is 1.8 million dam^3. Using the result of the 1992 PPWB Study, only 2.4 percent of the precipitation flows out of the basin as surface water under natural conditions. While a very small percentage of the received water may recharge groundwater systems, the vast majority of the water received is returned to the atmosphere either through evaporation from wetlands and the ground surface, or through transpiration from plants.

Median unit runoff is a measure that characterizes the typical surface runoff from an area. It is calculated by dividing the median runoff at a given location by the effective drainage area to that location. The units for unit runoff are dam^3/km^2 or millimetres. Using the results of the more recent PPWB study, the median runoff for the Pipestone Creek watershed to the Saskatchewan-Manitoba boundary is 24.9 mm.

Over the past four decades, streamflows of Pipestone Creek have been monitored by Environment Canada at three different locations and for different time periods as outlined in the following table. In addition to the three streamflow stations, there is also a water level station on Moosomin Reservoir.

Table 1 Hydrometric Stations in the Pipestone Creek Watershed

Station Number	Station Name	Station type	Years of Operation	Location	Description
05NE001	Pipestone Creek near Moosomin	Flow, eight month	1958-94	NW28-12-31-W1	at highway bridge immediately downstream of Moosomin Dam, about 10 km south of Moosomin
05NE002	Moosomin Reservoir	Level, eight month	1955-present	NW29-12-31-W1	
05NE003	Pipestone Creek above Moosomin Reservoir	Flow, eight month	1960-73, 1987-present	NW32-13-32-W1	on grid road upstream of Moosomin Reservoir, about 10 km west of Moosomin
05NG024	Pipestone Creek near the Saskatchewan Boundary	Flow, 12 month	Sep 1982 - present	NE18-10-29-W1	just off Highway 48, about 2 km west of Kola, Manitoba

Figure 1 shows the annual flow volumes recorded at each of the three streamflow stations. Annual volumes range from essentially zero in the early 1960's and late 1980's to a recorded maximum of over 188,000 dam^3 in 1976 below Moosomin. Figure 2 shows the variability of normalized annual flow volumes (i.e., all values were divided by the median value) below Moosomin as a probability distribution. The distribution shows that 80 percent of the volumes are less than two times the median flow and about 12 percent of the flow volumes are very close to zero.

Figure 1

Pipestone Creek Annual Volumes

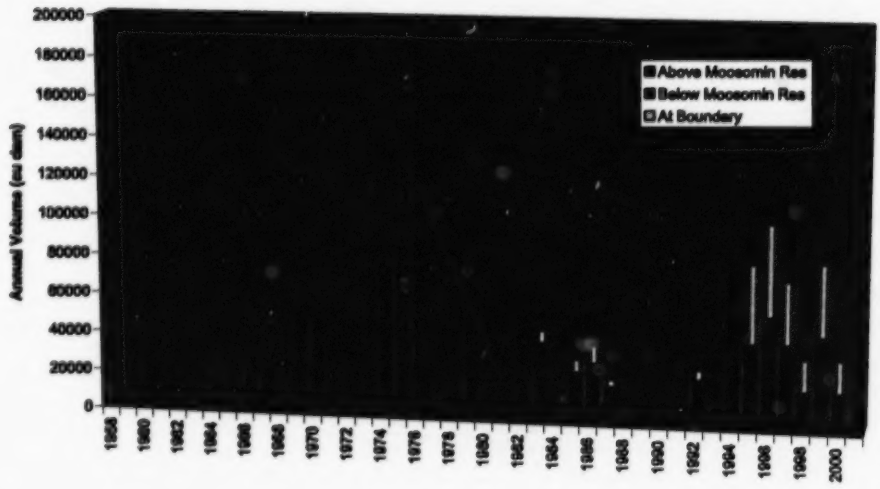
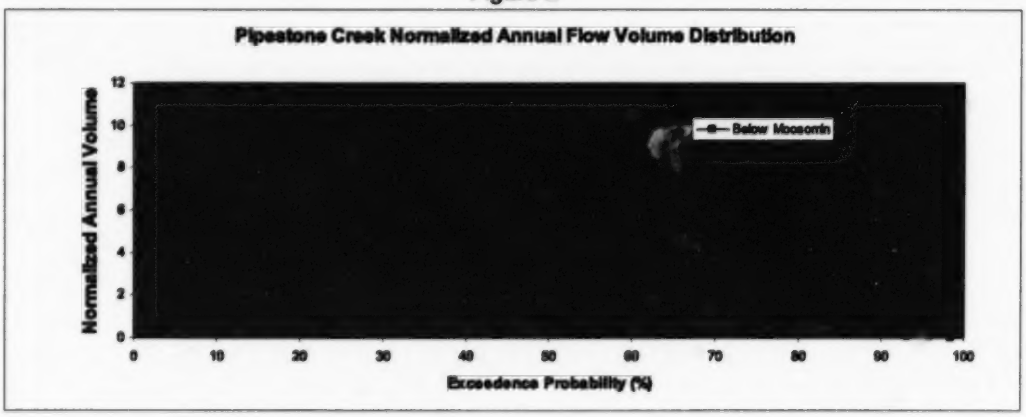
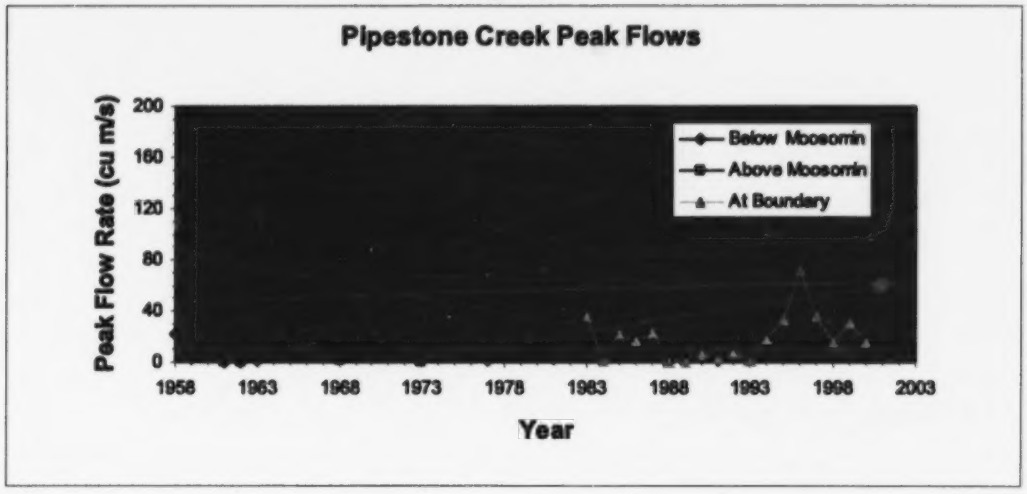


Figure 2



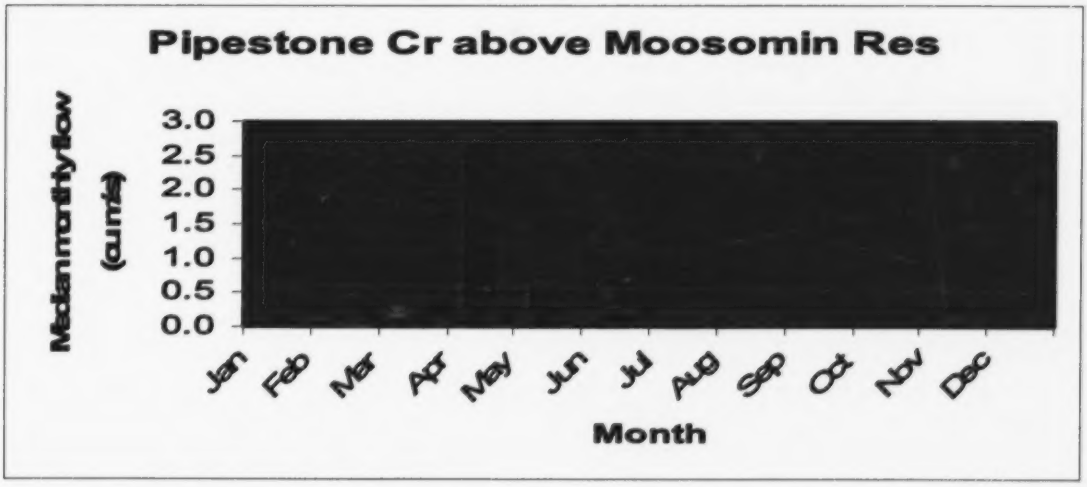
Similarly there is a high degree of variability in peak flows in the watershed as shown in Figure 3. The largest recorded flow occurred in 1976 when peak flows below Moosomin Dam were 176 m^3/s.

Figure 3



Flows vary throughout the year, with the highest flow months typically being April and May (see Figure 4). At the station above Moosomin Reservoir, winter flows are not recorded, but are generally zero. After the snowmelt peak, flows typically recede over the summer months and are often zero by mid-summer to late fall.

Figure 4



Water Use and Demand

The largest single water demand on Pipestone Creek is the obligation under the 1969 Master Agreement on Apportionment for Saskatchewan to provide to Manitoba fifty percent of the

natural flow of the creek at the Saskatchewan-Manitoba boundary. As discussed above, the average annual natural flow volume is 43,200 dam^3 and the median annual flow is 29,400 dam^3. This implies an obligation on Saskatchewan's part to deliver an average of 21,600 dam^3. The 1992 PPWB Study examined the ability of Saskatchewan to meet this obligation with the water demands and projects in place as of 1988. The study found that the average flow at the boundary is approximately equal to the natural flow. In extreme dry years, about 1 year in 10, water uses in the Saskatchewan portion of the basin would consume more than fifty percent of the natural flow. In those years the study found that the apportionment obligation could still be met by release of water from Moosomin Reservoir.

There are several significant water use projects in the Pipestone Creek watershed. Moosomin Reservoir is the largest single surface water use in the basin, with allocation for water use of 4,687 dam^3 and evaporation losses of 617 dam^3. The 1992 PPWB Study estimated the current long-term average annual net evaporation loss from Moosomin Reservoir to be 1,660 dam^3 per year. The dam was constructed by PFRA in 1953-54 and first filled in 1955. The reservoir provides water for the Town of Moosomin, irrigation and recreational use. It also provides for downstream water uses such as domestic, stockwatering, and municipal. In extremely dry years, releases can be made to ensure the apportionment requirement to Manitoba is met.

Pipestone Lake was a natural lake until the construction of a dam across its outlet in 1938. The original purpose was to provide water for domestic and stockwatering use downstream. Licenced allocations are for 1,505 dam^3 of use plus 345 dam^3 of evaporation loss. However, there are currently no direct uses out of the lake or licenced uses downstream which depend on releases from the lake. The dam was constructed with spillway in the south abutment, controlled by a timber pile sheet wall at an original crest elevation of 590.91 m. Over time, the timber weir has deteriorated and the overflow elevation of the lake is gradually returning to the original natural elevation of about 589.73 m.

In 1958, the Town of Grenfell constructed the Brown Hill Reservoir south of the Town in the Qu'Appelle River watershed. To increase the reliability of water supply to the reservoir, a diversion structure was placed on Pipestone Creek and a ditch constructed from the diversion to the reservoir. The gross and effective drainage areas to the diversion are 119.2 km^2 and 23.9 km^2 respectively. It is believed the diversion structure is rarely operated, resulting in most if not all of the water arriving at the diversion is directed to the Brown Hill Reservoir.

Municipal Water Use

There are eight communities which source their water from within the Pipestone Creek watershed as listed in the following Table. The surface water allocation to Grenfell of 253 dam^3 per year is tied to the Brown Hill Reservoir as discussed above. There is no specific allocation for use out of the Pipestone Creek watershed at the point of diversion. The Town of Kipling has two dams located south and south west of the Town with combined allocations of 336 dam^3. As discussed in the 1992 PPWB Study, the water supply for Moosomin is from two wells located adjacent to Moosomin Reservoir (GW #499 and #1957). Given the proximity of the wells to the reservoir, that study assumed the wells were recharged exclusively from the reservoir in order to conservatively estimate surface water use in the Saskatchewan portion of the watershed. However, no hydrogeological assessment has been made of the connection between the reservoir and the two wells, if any.

Table 2 Municipal Supplies within the Pipestone Creek Watershed

Community	Population (GRAA Municipal Directory website)	Water Source	Average Annual Consumption (dam^3/year), trend	Average per capita consumption (lcpd)
Grenfell	1067	Pipestone Cr plus local runoff in Qu'Appelle watershed	119 =	286
Kennedy	243	groundwater	n/a	n/a
Kipling	1037	Local surface water plus groundwater	151 =	386
Langbank	n/a (organized hamlet)	groundwater	n/a	n/a
Moosomin	2361	groundwater	439 =	470
Wapella	354	groundwater	59.5 -	382
Wawota	538	groundwater	64.9 -	292
Windthorst	228	groundwater	22.9 +	219
Totals	5828		856	403

= stable
- declining
+ increasing
n/a not available

Domestic Surface Water Demand

There are 24 domestic surface water projects with either Approval to Construct (AtC) or Approval to Operate (AtO) from the Saskatchewan Watershed Authority scattered throughout the Pipestone Creek watershed. Allocations to these projects total 94 dam^3 per year. This does not include Pipestone Lake discussed above which is also listed as a "domestic" project. Water use from these 24 domestic projects may be for in-home use, garden watering, watering of livestock, and/or spray water.

Irrigation Water Demand

There are 19 authorized (either with AtC or AtO) irrigation projects in the Pipestone Creek watershed. Allocations to these projects total 376 dam^3. The 19 projects are scattered throughout the watershed, however the larger projects are sourced out of the firmer supplies such as Kipling Marsh, Pipestone Creek near Moosomin Reservoir, and from Moosomin Reservoir itself. Irrigation projects are licenced as either *intensive*, indicating they have access to water through the summer irrigation season, or as *non-intensive*, indicating they access water only during spring runoff.

The 1992 PPWB study examined three irrigation projects; WR # 14504, WR # 14251, and the Moosomin Golf Course. Project #14504 originally had an allocation of 451 dam^3 from Moosomin Reservoir. This project has since been altered, and now has an allocation of 117

dam^3. Similarly, Project #14251 originally had an allocation of 138 dam^3 from a small tributary of Moosomin Reservoir. That allocation has now been revised to 17 dam^3.

Lastly, in the 1992 PPWB Study the Moosomin Golf Course was assumed to use an average of 57.2 dam^3 per year based on reported water usage. As this project has not yet received authorization from the Saskatchewan Watershed Authority, the water use/demand was not included in the total given above.

Industrial Water Use

There is only industrial surface water allocation in the Pipestone Creek watershed. Water Right #514 is held by the CNR for the dam near Kelso on a tributary of the Little Pipestone Creek. The authorization allows for use of 160 dam^3 per year and evaporation loss of 37 dam^3 per year for a total allocation of 197 dam^3. It is likely safe to assume the only current use in the evaporation loss.

"Other" and "Multiple" Water Uses

There are a total of 13 projects in the Pipestone Creek watershed listed as either "Other" or "Multiple" in the SWA Water Rights database. One of the "Multiple" projects is Moosomin Dam discussed above. The remaining 12 projects are owned by Ducks Unlimited and represent total allocations of 1,262 dam^3. It should be noted that most DU projects involve water level control structures on existing wetlands which allow for stabilization of the water level and occasional manipulation of water levels to achieve optimum duck breeding and rearing habitat. In many cases, the normal operating level of the project is lower than the original natural outlet of the wetland. The allocations to these projects for the most part are for evaporation losses which would have occurred without the project. The authorization secures for Ducks Unlimited the right to access water for their purposes.

Drainage Projects

There are five Conservation Area Authorities (CAA's) located either wholly or partially in the Pipestone Creek watershed. Three of the CAA's have projects which affect flows in Pipestone Creek. In addition, there are six authorized individual drainage projects and one Highways project in the watershed.

The Kingsley CAA owns and operates the Kipling Marsh drainage project. The project involves a number of ditches within the Kipling Marsh north of the Town of Kipling. These ditches lead to a pump station at the east side of the marsh. From there water is pumped out of the marsh, into a ditch through the natural divide and then flows to Pipestone Lake. Since the natural divide is about 6.7 m above the marsh elevation, the marsh would not contribute to flows of Pipestone Creek under natural conditions. The 1992 PPWB Study estimated the long-term average increase in Pipestone Creek flow due to the Kipling Marsh Project to be 3,540 dam^3.

The Silverwood CAA has a project which increases the effective drainage area into Pipestone Lake by 3.76 km^2. The 1992 PPWB Study estimated the long-term average increase in inflow to be 47 dam^3 per year. The Moosomin CAA has a project which increases the effective drainage area to Pipestone Creek below Moosomin Reservoir by 11.1 km^2. The 1992 PPWB Study estimated the long-term average increase in streamflow volume to be 223 dam^3 per year.

A small area was drained in association with the construction of Highway #8 south of Moosomin in the mid-1950's. The increase in effective area into Moosomin Reservoir is 3.23 km^2. The 1992 PPWB Study estimated the long-term average increase in inflow to be 47 dam^3 per year.

The effect of the authorized individual drainage projects in the watershed and the effect of unauthorized projects has not been assessed. Studies of the effects of drainage in other watersheds have found that drainage projects increase runoff volumes in low and median runoff years but have a diminishing effect in increasingly higher runoff years. This is because in high runoff years the area affected by the drainage project would have contributed to flow even under natural conditions. The obvious exception to this is the Kipling Marsh Project which would not contribute to flow under natural conditions.

References

Environment Canada Website giving 1971-2000 Climate Normals

PFRA 2003 Spreadsheet update to The Determination of Gross and Effective Drainage Areas in the Prairie Provinces. Hydrology Report #104. May 1983.

PPWB 1979 Natural Flow - Pipestone Creek at the Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology. Prepared by Hydrology Division Prairie Farm Rehabilitation Administration, Department of Regional Economic Expansion. March 1979.

PPWB 1992 Natural Flow - Pipestone Creek at the Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology. Prepared by Water Management Division Sask Water. December 1992. PPWB Report #116.

Appendix 4

Overview of the Hydrology of the Antler River in eastern Saskatchewan

Drainage Areas

There are a number of streams which flow eastward out of Saskatchewan to join the Souris River in Manitoba. One of these is the Antler River.

The gross and effective drainage areas of the Antler River to the Saskatchewan Manitoba boundary are 2,875 km^2 and 1,217 km^2 respectively. Since some of the area in Saskatchewan is tributary to the river downstream of the boundary crossing, the total gross area in Saskatchewan is 3,069 km^2 and the total effective area is 1,331 km^2.

Previous Hydrology Studies

The hydrology of the Antler River watershed in Saskatchewan has been the subject of one study carried out on behalf of the PPWB Committee on Hydrology completed in December 1978, which will be summarized here. Additional hydrology studies have been conducted for various projects in the watershed which will be discussed in the water use portion of this report.

1978 Natural Flow Study (PPWB, 1978)

Using a 66-year study period (1912-77), the average annual natural flow volume of Antler River at the Saskatchewan-Manitoba boundary was found to be 21,900 dam^3. The median annual flow volume was found to be 12,200 dam^3. The natural flow study considered the effects of some 35 water use projects, including the Auburnton Creek Reservoir, the Carnduff Reservoir, and the Redvers Reservoir.

Basin Hydrologic and Runoff Characteristics

The mean annual precipitation for the Antler River watershed varies from around 430 mm at Carlyle to about 525 mm at Carnduff (1971-2000 Climatic Normals, Environment Canada). If the average precipitation over the whole watershed is assumed to be 475 mm, then the average volume of water received by the watershed is 1.4 million dam^3. Using the result of the 1978 PPWB Study, an average of only 1.6 percent of the precipitation flows out of the basin as surface water under natural conditions. While a very small percentage of the received water may recharge groundwater systems, the vast majority of the water received is returned to the atmosphere either through evaporation from wetlands and the ground surface, or through transpiration from plants.

Median unit runoff is a measure that characterizes the typical surface runoff from an area. It is calculated by dividing the median runoff at a given location by the effective drainage area to that location. The units for unit runoff are dam^3/km^2 or millimetres. Using the results of the PPWB study, the median runoff for the Antler River to the Saskatchewan-Manitoba boundary is 10.0 mm.

Streamflows of Antler River are available by Environment Canada at three different locations for

the time periods as outlined in the following table. A fourth site, Antler River near Western Crossing was operated manually between 1978 and 1986 for miscellaneous measurements. In addition to the Environment Canada streamflow stations, PFRA monitored water levels of the Redvers Reservoir for a number of years.

Table 1 Hydrometric Stations in the Antler River Watershed

Station Number	Station Name	Years of Operation	Location
05NF002	Antler River near Melita	1935-36, 38, 43-present	NE 01-27-01-W1
05NF006	Lightning Creek near Carnduff	1935-36, 73-present	NE 15-03-32-W1
05NF010	Antler River near Wauchope	1965-present	NW 24-7-33-W1

Figure 1 shows the annual flow volumes recorded at each of the three streamflow stations. Annual volumes range from zero in the early 1960's and late 1980's to a recorded maximum of over 186,000 dam^3 in 1976 near Melita. Figure 2 shows the variability of normalized annual flow volumes (i.e., all values were divided by the median value) near Melita as a probability distribution. The distribution shows that 73 percent of the volumes are less than two times the median flow and about 11 percent of the flow volumes are zero. Due to their smaller drainage areas, similar plots for Antler River near Wauchope and Lightning Creek would show even higher peak annual flows relative to the median, and would show more frequent occurrences of low and zero flow.

Figure 1

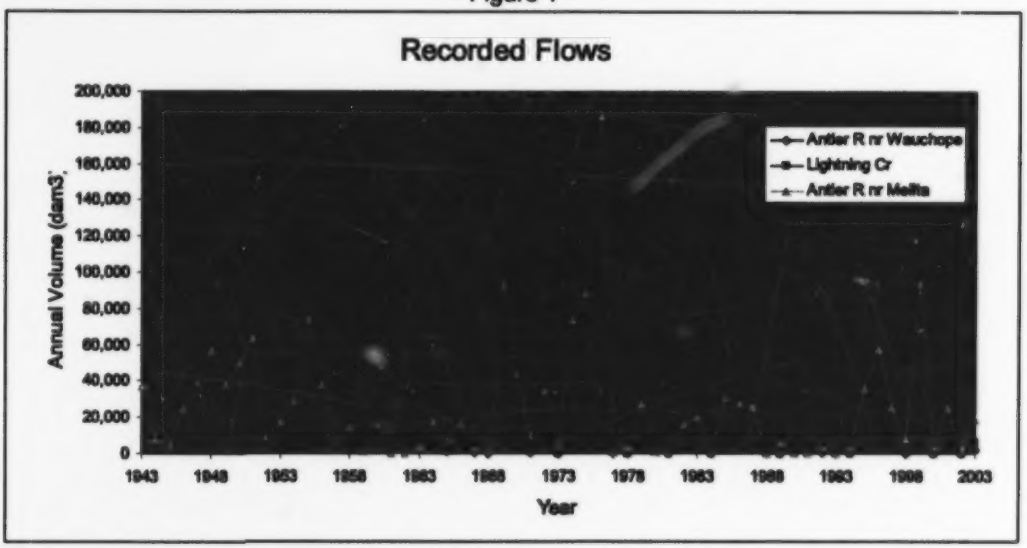
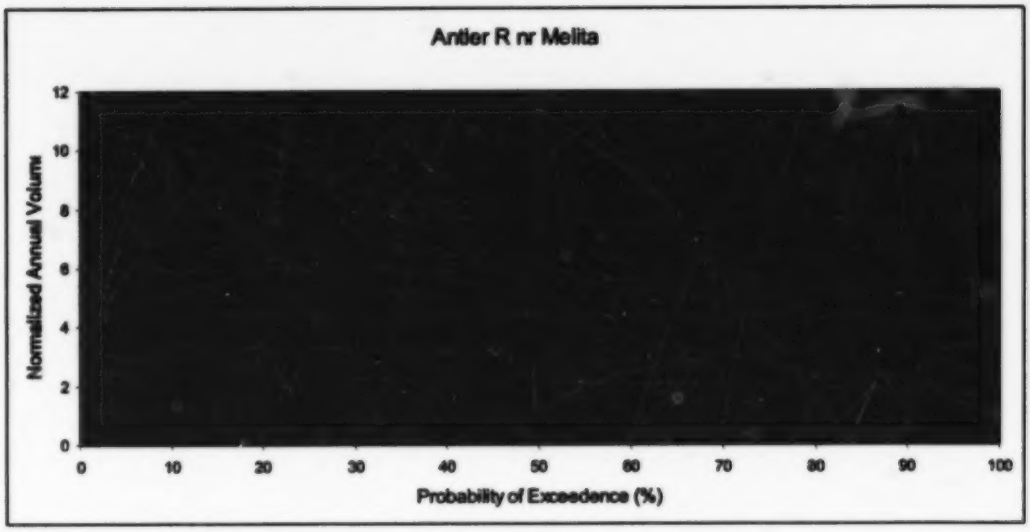
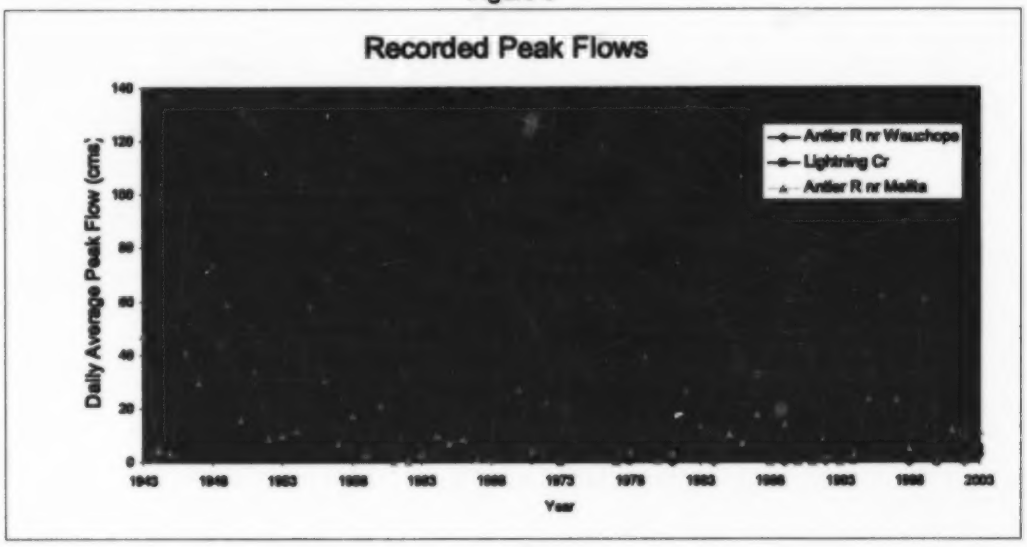


Figure 2



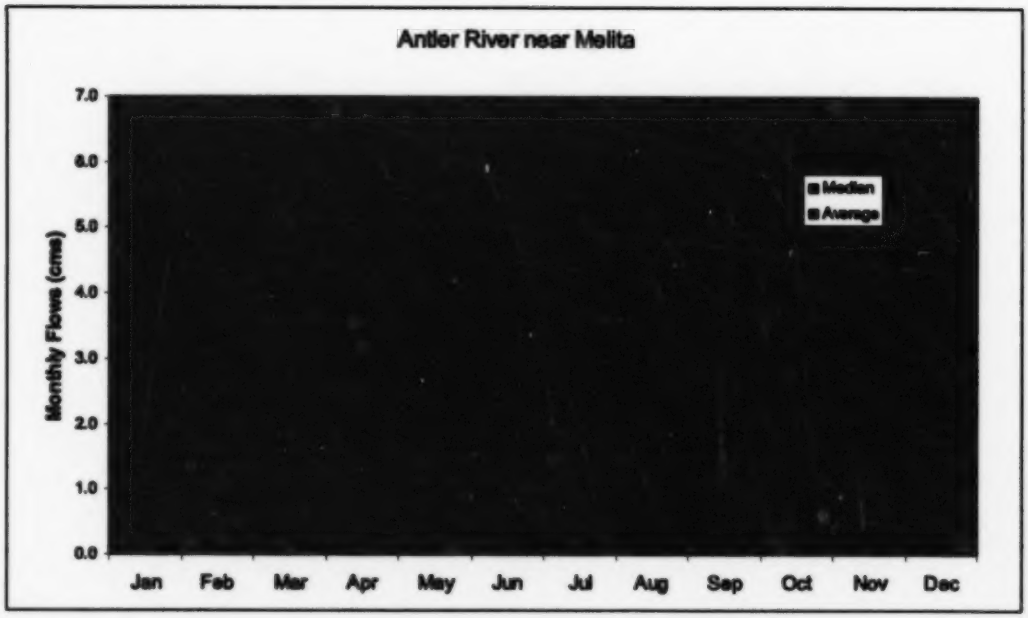
Similarly there is a high degree of variability in peak flows in the watershed as shown in Figure 3. The largest recorded flow occurred in 1976 when peak flows near Melita were 118 m^3/s.

Figure 3



Flows vary throughout the year, with the highest flow months typically being April (see Figure 4). After the snowmelt peak, flows typically recede over the summer months and are often zero by mid-summer to late fall.

Figure 4



Water Use and Demand

The largest single water demand on Antler River is the obligation under the 1969 Master Agreement on Apportionment for Saskatchewan to provide to Manitoba fifty percent of the natural flow of the creek at the Saskatchewan-Manitoba boundary. As discussed above, the average annual natural flow volume is 21,900 dam^3 and the median annual flow is 12,200 dam^3. This implies an obligation on Saskatchewan's part to deliver an average of 10,950 dam^3. The 1978 PPWB Study examined the ability of Saskatchewan to meet this obligation with the water demands and projects in place as of 1977. The study found that the average annual water use at the time amounted to about five percent of the average annual natural flow at the boundary. In extreme dry years, water uses in the Saskatchewan portion of the basin would approach fifty percent of the natural flow

There are three significant water use projects in the Antler River watershed. Auburnton Reservoir is the largest single surface water project in the basin. While there are currently no uses from the reservoir, evaporation losses average about 400 dam^3 per year. Carnduff Reservoir has evaporation losses in the order of 280 dam^3 per year. Redvers Reservoir has combined municipal use and evaporation loss in the order of 180 dam^3 per year.

Municipal Water Use

There are six communities which source their water from within the Antler River watershed as listed in the following Table. The village of Manor straddles the watershed divide between Antler River and Moose Mountain Creek, however its municipal water source in from the Antler River watershed.

Table 2 Municipal Supplies within the Antler River Watershed

Community	Population (GRAA Municipal Directory website)	Water Source	Average Annual Consumption (dam3/year), trend	Average per capita consumption (lcpd)
Alida	117	Groundwater wells located adjacent to the Antler River	18.8 -	284
Carievale	254	Groundwater	39.0 +	367
Carnduff	1017	Groundwater wells located adjacent to the Antler River	221 +	550
Glen Ewen	158	Groundwater	20.8 =	343
Manor	305	Groundwater wells located adjacent to a reservoir on Auburnton Creek	33.9 +	270
Redvers	917	Groundwater wells located adjacent to Redvers Reservoir on Lightning Creek	102 -	279
Storthoaks	99	Groundwater wells located adjacent to Lightning Creek	15.6 =	293
Totals	2,867		451	431

= stable
- declining
+ increasing

There are three surface water reservoirs associated with communities in the watershed. Some reservoir attributes are listed in the following table.

Carnduff Reservoir

Reservoir	Capacity (dam^3)	Area (ha)	Licensed Diversion (dam^3)
Carnduff	977	57.5	394
Manor	80.2	14.2	93
Redvers	235	19.0	74

Domestic Surface Water Demand

There are 22 domestic surface water projects scattered throughout the Antler River watershed. Allocations to these projects total 92 dam^3 per year. Water use from these projects may be for in-home use, garden watering, watering of livestock, and/or spray water.

Irrigation Water Demand

There are four authorized irrigation projects in the Antler River watershed. Allocations to these projects total only 33 dam^3. In addition, the Auburnton Reservoir is registered as an irrigation project, however no irrigation has been developed out of the reservoir. Auburnton Reservoir has storage capacity of 2,160 dam3, and a surface area of 83.0 ha.

Industrial Water Use

There are no industrial surface water allocations in the Antler River watershed.

"Other" Water Uses

There are two projects in the Antler River watershed listed as "Otherin the SWA Water Rights database. Both are projects owned and operated by Ducks Unlimited with combined licensed diversions of 296 dam^3.

Drainage Projects

There are no significant authorized drainage projects in the Antler River watershed.

References

Environment Canada Website giving 1971-2000 Climate Normals

PFRA 2003 Spreadsheet update to The Determination of Gross and Effective Drainage Areas in the Prairie Provinces. Hydrology Report #104. May 1983.

PPWB 1978 Natural Flow - Antler River at the Saskatchewan-Manitoba Boundary, Technical Report to the PPWB Committee on Hydrology. Prepared by Hydrology Division Prairie Farm Rehabilitation Administration, Department of Regional Economic Expansion. December 1978.

Appendix 5

Moosomin Reservoir 2004 Water Quality Report

This study reviews and assesses the existing water quality data for the Saskatchewan portion of the Lower Souris Watershed. This data set reflects municipal wastewater effluent monitoring and is not conducive to assessment of overall water quality.

Moosomin reservoir has a more comprehensive data set that permits assessment of ambient water quality. Since 2001 SWA with the assistance of the local stewards, have conducted sampling on the reservoir. Current sampling sites include a baseline site (across from the Regional Park store) and two shoreline sites. In 2003 a site upstream of Pipestone Creek on the 709 grid was sampled and in 2004 two sites near stewardship project sites were sampled. Please see map for site locations.

The data for Moosomin reservoir was used in the Canadian Water Quality Index (WQI). The WQI is an effective means for summarizing a large number of water quality parameters and provides an indication of overall water quality. The index compares values for various water quality parameters (i.e. nutrients, dissolved minerals, metals) to water quality objectives. The results of those comparisons are combined to provide a water quality ranking system (excellent, good, fair, poor) for each individual water body. The ratings are compiled based on a combination of three factors - scope, frequency and amplitude. Scope refers to the total number of tested parameters whose objectives are exceeded. Frequency is the number of times the objectives are not met. Finally amplitude is the amount by which the objectives are not met. Listed below is a description of the ratings system on a scale of 0 to 100.

Excellent: (WQI Value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels. These index values can only be obtained if all measurements are within objectives virtually all of the time.

Good: (WQI Value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.

Fair: (WQI Value 60-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.

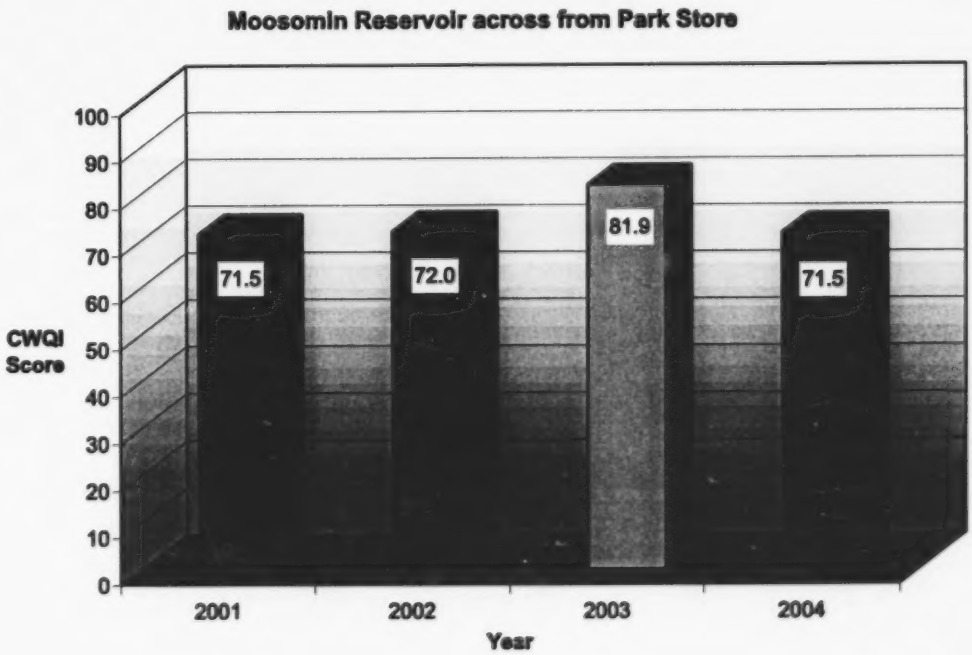
Marginal: (WQI Value 45-59) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.

Poor: (WQI Value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

The WQI parameters and the SWA objectives are listed in the table below.

Chloride Dissolved	100 mg/L
Arsenic Total	50 ug/L
Chromium Total	0.02 mg/L
Nitrogen Total Ammonia	Temperature & pH dependent - reported in mg/L
Mercury	0.1 ug/L
Sodium Dissolved	100 mg/L
pH	6.5 - 8.5
Dissolved Oxygen	5 mg/L
2`4-D	4 ug/L
MCPA	0.025 ug/L
Fecal Coliform	200 units/100 mL
Sulphate	500 mg/L
Phosphorous Total	0.1 mg/L
Aluminium Total	5 mg/L
Nitrogen Dissolved - NO_3 & NO_2	1 mg/L
Total Dissolved Solids	700 mg/L
Chlorophyll *a*	50 ug/L

The WQI score for Moosomin Reservoir is in the fair to good range. Please see the chart below.



Three parameters are largely responsible for influencing the WQI. They are total phosphorous, total dissolved solids and chlorophyll *a*.

Total phosphorus is a key and limiting nutrient in algae and aquatic plant growth. Sources of total phosphorus include fertilizers, decay of organic matter, treated sewage effluent discharges, and leaking septic systems. The total phosphorous objective used in the WQI is 0.1 mg/L.

Total phosphorus can vary seasonally in lakes and streams. Increased stream velocity will cause natural erosion of stream banks and channels adding soil that contains natural phosphorous. Spring runoff and rainfall events add phosphorous from fertilizers and manure from fields along with natural phosphorous. Spring is when municipalities typically discharge their lagoon wastewater effluent. Total phosphorous levels ranged from 0.09 to 0.34 mg/L.

Total dissolved solids (TDS) are a measure of the amount of dissolved substances in the water. Sources include: soil erosion, discharge of waste municipal and industrial agricultural run-off and groundwater (springs). Levels for irrigation ideally should not exceed 700 mg/L. TDS levels ranged from 762 mg/L to 1192 mg/L.

Chlorophyll *a* is a green pigment found in plants and is used to measure the quantity of algae in a water body. Levels in the reservoir ranged from 5 to 172 ug/L. Levels below the SWA WQI objective of 50 ug/L will still demonstrate algae growth.

Dissolved oxygen (DO) readings in the reservoir consistently remained above the 5 mg/L during the open water season. During the winter months ice cover the reservoir does not permit oxygen to be reintroduced to the water from the environment. During March sampling the DO has been shown to be near 1 mg/L during at the baseline site.

Pesticide and herbicide sampling occurred in 2003 on Moosimin Reservoir. The results indicated non-detectable levels. These products degrade rapidly in water. The tests are expensive and with limited financial resources they were not collected in 2004.

To obtain a complete listing of water quality results please contact Kevin O'Neill, Saskatchewan Watershed Authority Weyburn, at (306) 848-2352.

References

Hughes C.E. Synopsis of Water Quality in Pipestone Creek, Manitoba, Canada, 1996 through 2003. Manitoba Watershed Stewardship, 2004.

Appendix 6

Saskatchewan Watershed Authority

Abandonment Test Holes and Wells

Fact Sheet

Contamination of ground water resources has not been a major problem in most parts of Saskatchewan, due in large to the forgiving nature of the geology The surficial glacial tills have served to protect this resource by intercepting most of the contamination and holding it until it can be naturally broken down into non-harmful products. It also follows that if this protective shield can remove harmful products, then it also will be that much more difficult to clean up after contamination occurs

Any time a hole is completed, an avenue for contamination is opened For this reason, abandonment of test holes and the decommissioning of wells is critical if we are to protect this vital resource

Test Hole Abandonment

Saskatchewan's *Ground Water Regulations* state that, "when a test hole is abandoned without well completion, the driller shall immediately seal and fill this test hole with suitable uncontaminated material in a manner so as to prevent the detrimental vertical movement of water in the hole."

Dry Auger Test Holes

If no suitable formation is encountered, then the test hole should be filled with the material removed using the auger to compress the fill. A bentonite plug should be placed at the top 2 feet to prevent any surface contamination from entering the hole

If a formation is encountered and a well is to be completed at this site within a reasonable time, then a 2-foot seal of bentonite should be placed before leaving the test hole site.

If a sand or gravel layer is encountered and no well is to be completed at this site, then the hole should be filled with the material removed during drilling. This material (containing as much clay as is available) should be compressed with the auger and the bentonite plug should extend to the 10-foot level.

If more than one formation is encountered and no well is to be completed, then an attempt must be made to seal the hole to prevent vertical movement between formations. This would mean that the hole should be plugged with bentonite from below the lowest formation to above the highest formation. To accomplish this, bentonite pellets must be used and slowly added to fill the total depth of the hole. An alternative would be to mix a high solids mud and pump the hole full from the bottom to the top

Rotary Test Holes

If no suitable formation is encountered, then the test hole should be filled with the material removed. A bentonite plug should be placed at the top 2 feet to prevent any surface contamination from entering the hole.

If a sand or gravel layer is encountered and no well is to be completed at this site, then bentonite or a high solids mud should be used to fill the hole.

Well Abandonment

When a well is abandoned after the date of completion, the owner shall immediately fill and seal the well or cause the well to be filled with suitable uncontaminated material in a manner as to prevent the detrimental vertical movement of the water in the well.

Small Diameter Wells (drilled)

All materials must be removed and the hole must be filled with a high solids grout or cement.

If in the original construction the casing was cemented in place, then casing removal may not be possible. In this case, only the abandoned well shall be pressure grouted with a high solids grout or cement and the upper 10 feet shall be removed. A cover plate at least ¼ inch thick shall be permanently fixed to the casing and a 1-foot thick layer of bentonite placed over the capped well. The excavation shall then be backfilled to surface with impervious material.

Large Diameter Wells (bored)

As much casing as possible should be removed. This can be more of a problem with bored wells. The bottom 1-foot of the well should be sealed with bentonite, and then backfilled to 10 feet below ground (tamping if possible). The casing should be removed at the 10-foot level and the well sealed with a 1-foot layer of bentonite. The excavation should then be backfilled with impervious material.

Well Construction

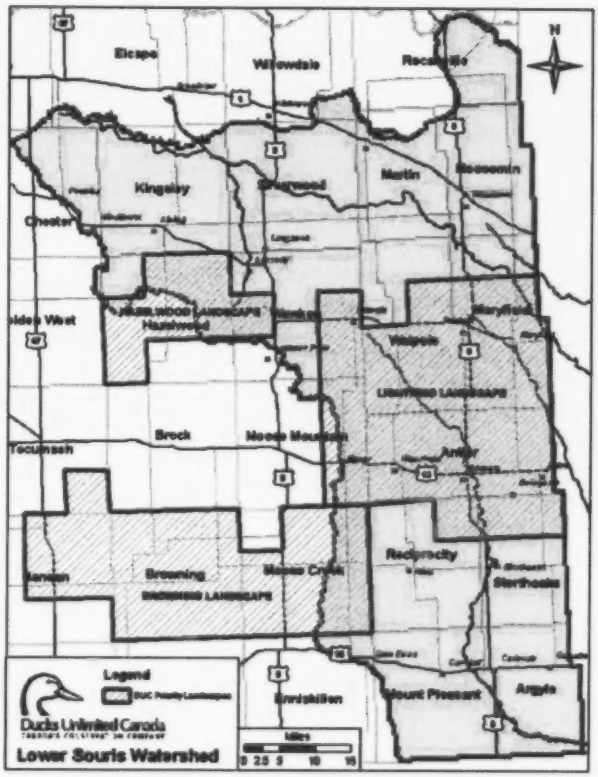
A well shall be constructed so as to effectively prevent the entrance of surface water or other deleterious matter into any aquifer, and to prevent any mixing of water.

Because the drilling of a well exposes an aquifer to potential surface contamination, the annulus between the casing and the borehole should be sealed. A layer of bentonite pellets should be placed above the gravel pack to prevent any surface water intrusion or to prevent movement between formations.

Appendix 7

Lower Souris River Watershed Background Information

In the early 1990's, Ducks Unlimited Canada went through a process of prioritizing the program delivery areas within the Prairies into Landscapes. As part of this process, information available at the time was collected and summarized by landscape. Two of the Landscapes that were setup fall within the Lower Souris River Watershed; the Lightning River Landscape and the Hazelwood Landscape.



The Lightning River Landscape lies almost entirely in the central portion of the Lower Souris RiverWatershed spanning across both the Four Creeks and Antler sub-watersheds. The northeast half of the Hazelwood landscape falls in the Pipestone sub-watershed.

Wetlands: Lightning Creek Landscape

The gently rolling moraine is well interspersed with numerous small wetlands typically fringed by aspen and willow. This landscape has one of the highest pothole densities in Saskatchewan. Larger wetlands are noticablely absent in the Lightning Creek landscape. Although a few wetlands are channel and terminal basin marshes, most are tall rush, deep marsh or tall grass shallow marsh wetlands where the water source is chiefly surface flow or ground water inflow. Most wetlands are fresh to moderately saline and support high proportions of emergent deep marsh interspersed with shallow open water.

According to the 1986 satellite habitat inventory, the Lightning Creek landscape has 46,798 wetlands totaling 70,094 acres with a pond density of 2 to 120 per square mile. Approximately 57% of the sections in this landscape ranked within the top three density and permanency ranges which consisted of 42 to 120 wetlands and 5 to 11 acres of permanent water per section.

Evaporation is considered moderate for this part of the province and pond loss from May to July is estimated at 50%.

The following table presents a summary of the 1986 wetland habitat inventory for each of the 31 townships in the Lightning Landscape. It should be noted that the satellite technology available in 1986 limited the ability to identify small temporary potholes that make up an important portion of the landscape.

Satellite Inventory Wetland Summary By Township.

TWP	WETLAND SIZE CLASS									WETLAND ACRES			
	<1.9	<5	<10	<25	<50	<100	<500	<1000	+1000	OW	DM	SM	TOTAL
11-01-2	135	155	64	34	9	4	2	0	0	6	3	1473	1482
11-32-1	1007	178	50	30	5	5	3	0	0	267	340	2205	2812
11-31-1	860	101	34	36	8	6	4	0	0	108	330	1916	2354
11-30-1	954	128	29	16	4	4	0	0	0	15	157	1341	1513
10-01-2	112	140	80	28	12	5	2	0	0	2	0	1464	1466
10-34-1	473	59	23	22	4	2	1	0	0	121	94	1138	1353
10-33-1	1864	228	72	25	6	3	1	0	1	66	153	2832	3051
10-32-1	1224	219	94	54	11	1	1	0	0	127	348	2743	3218
10-31-1	1363	185	67	44	16	6	1	0	0	76	291	2796	3163
10-30-1	1484	112	32	13	3	3	0	0	0	27	163	1239	1429
9-01-2	1108	209	71	27	3	0	1	0	0	35	117	2135	2287
9-34-1	418	93	31	18	4	0	1	0	0	69	111	1124	1304
9-33-1	1456	335	128	63	16	11	10	0	0	474	695	4897	6066
9-32-1	1814	300	86	51	10	4	2	0	0	91	264	3631	3986
9-31-1	1905	240	54	24	6	1	0	0	0	30	143	2612	2785
9-30-1	1615	165	20	8	2	1	0	0	0	15	194	1138	1347
8-01-2	1318	120	8	2	0	0	0	0	0	4	37	1068	1113
8-34-1	640	101	21	4	0	0	0	0	0	6	47	835	888
8-33-1	1765	319	117	54	11	5	3	0	0	203	408	3708	4319
8-32-1	1848	357	75	36	6	3	2	0	0	122	303	3171	3596
8-31-1	2176	302	54	20	6	1	1	0	0	23	131	2857	3011
8-30-1	1599	128	20	6	1	0	1	0	0	29	122	1014	1165
7-01-2	623	59	4	1	1	0	0	0	0	3	33	518	554
7-34-1	497	82	17	0	0	0	0	0	0	16	59	587	662
7-33-1	1966	343	46	13	2	0	0	0	0	58	218	2447	2723
7-32-1	2012	346	61	13	2	1	0	0	0	51	190	2687	2928
7-31-1	1704	245	57	19	3	0	0	0	0	24	124	2262	2410
7-30-1	1249	62	2	1	2	0	0	0	0	11	66	487	564
6-32-1	1637	175	19	2	0	0	0	0	0	22	101	1520	1643
6-31-1	1014	95	14	5	0	0	0	0	0	31	17	951	999
6-30-1	1198	33	1	0	0	0	0	0	0	6	12	509	527

Wetlands: Hazelwood Landscape

The wetlands throughout the landscape are classified by the Canadian Wetland Classification System as primarily kettle marsh with well defined edges and a fairly steep gradient from the edge to the deepest portion of the basin. The wetlands in the northeastern parts of the landscape are more typical of shallow basin marsh wetlands with less distinct catch basins. Water sources are local run-off with some limited ground water inflow. Very few wetlands in the landscape lie along streams with seasonal or ephemeral flow. In the western part of the landscape the relief increases and there are a number of larger, flat-bottomed wetlands that would be classified as permanent open water terminal basins.

According to the satellite habitat inventory the Hazelwood landscape has 4,481 wetlands totaling 23,076 acres with a pond density of 0 to 42 per square mile. Approximately 47% of the sections with satellite coverage in this landscape ranked within the top three density and permanency ranges which consisted of 10 to 42 wetlands and 8 to 129 acres of permanent water per section. A total of 12 sections, or 4.7% of the area, in the Hazelwood landscape had data unavailable.

Evaporation is considered moderate for this part of the province and pond loss from May to July is estimated at 50%.

The following table presents a summary of the satellite inventory (1990) for wetlands in each of the townships in the landscape that fall in the Pipestone Sub-basin.

Satellite Inventory Wetland Summary By Township.

TWP	WETLAND SIZE CLASS							WETLAND ACRES			
	<1.9	<5	<10	<25	<50	<100	<500	OW	DM	SM	TOTAL
11-03	172	239	118	80	21	10	2	185	59	3692	4077
11-04	242	265	153	87	24	1	6	211	60	4166	4672
12-04	207	179	74	31	3	1	1	33	12	1407	1986
12-05	350	176	80	64	5	1	-	106	62	2245	2492

Waterfowl (Lightning and Hazelwood Landscapes)

Historical data from USFWS/CWS Stratum 35 transects specific to the landscape for the years 1971 through 1990 (Table 3) indicate that mean breeding mallard density ranged from a low of 8/square mile in 1988-89 to a high of 47/square mile in 1976.

Number of Breeding Mallards Per Square Mile in Lightning Creek and Hazelwood Landscapes.

YEAR	Lightning Landscape MALLARDS/Sq/Mi	Hazelwood Landscape MALLARDS/Sq.Mi
1971	23	28
1972	28	34
1973	17	22
1974	18	23
1975	28	37
1976	41	47
1977	20	21
1978	22	30
1979	29	30
1980	26	30
1981	15	23
1982	24	29
1983	18	21
1984	10	13
1985	10	15
1986	22	25
1987	18	18
1988	8	11
1989	8	12
1990	9	15

According to the USFWS data (1992) for stratum 35, the species composition of ducks is approximately 90% dabblers and 10% divers. Mallards make up 26% of the duck population, blue-winged teal 30%, northern shoveler 11%, gadwall 13% and northern pintail 8%. The most common divers are lesser scaup (3%), redhead (2%), and ruddy duck (3%).

OTHER WILDLIFE: Lightning Creek Landscape

The Lightning Creek landscape is primarily in the Gainsborough Creek Plain habitat sub-region (4.58) as defined in the Environment Canada "Priority Migratory Bird Habitats of Canada" (1990). In overall importance the Gainsborough Creek Plain is ranked as locally important for migratory birds. It is nationally important for breeding ducks, locally important for breeding colonial water birds (great blue heron) and locally important for breeding populations of threatened species (burrowing owl; loggerhead shrike).

Approximately 5% (208 quarters) of the landscape has been identified by the Saskatchewan Natural Resources "Terrestrial Habitat Inventory" as habitat important for white-tailed deer, sharp-tailed grouse and ruffed grouse.

There are relatively few small blocks of non or minimally disturbed vegetation communities representing the historical native community within the Lightning Creek landscape. These areas, while providing critical habitat to a host of floral and faunal species, are under constant threat of alternation or destruction from agricultural development. The majority of native vegetation is used as small pastures (10 to 30 acres) and is heavily grazed by cattle.

OTHER WILDLIFE: Hazelwood Landscape

The Hazelwood landscape falls primarily within the Moose Mountain habitat sub-region (4.57) as defined in the Environment Canada "Priority Migratory Bird Habitats of Canada" (1990). This area is rated as locally important for breeding ducks and regionally important for breeding colonial birds. A portion of the landscape falls within the Moose Mountain Upland habitat subregion (4.55), This area is rated as having regional importance for breeding ducks, breeding geese, staging geese and breeding colonial birds. The area is also nationally important for non-breeding colonial birds.

Approximately 70% square miles (28% of landscape) has been identified by the Saskatchewan Natural Resources "Terrestrial Habitat Inventory" as habitat important for elk, moose, white-tailed deer, beaver and ruffed grouse. An additional 18 square miles (7% of the landscape) is important for sharp-tailed grouse and the endangered ferruginous hawk.

The Hazelwood landscape lies entirely within the Aspen Parkland ecoregion, 80% of which has been converted to agriculture and continues to be heavily impacted. The mixed prairie component of the landscape is characterized by a Porcupine grass/wheatgrass community. This is an endangered vegetation complex and there are remnant pockets representing this community type within the landscape. According to the Prairie Conservation Action Plan (1989) only 24% of the original mixed prairie remains, greater than 50% of this is overgrazed. In addition the landscape abuts Moose Mountain Provincial Park, a remnant of aspen forest. Therefore the Hazelwood landscape lies in the important transition zone between forest and grassland and as such would represent a separate community.

A number of endangered species' historical range extends into the Hazelwood landscape. A sample list of some of these species follows with their rank according to the Saskatchewan Conservation Data Centre.

SPECIES	RANK
Loggerhead Shrike	Cause for long term concern
Baird's Sparrow	Rare or Uncommon
Cooper's Hawk	Vulnerable
Northern Leopard Frog	Rare or Uncommon
Side-Oats Grama	Rare or Uncommon
Trillium	Imperiled in the Province
Showy Lady's Slipper	Critically imperiled in the Province

This landscape may also be important to a number of woodland margin species including small passerines such as warblers. There are a few isolated blocks of non or minimally disturbed vegetation communities representing the historical native community within the Hazelwood landscape. These areas, while providing critical habitat to a host of floral and faunal species, are under constant threat of alteration or destruction from agricultural development.

Ducks Unlimited Canada Program

Lower Souris River Watershed - Ducks Unlimited Project Summary

Securement Method	Wetland		Upland		Total Acres
	# of Segments	Wetland Acres	# of Segments	Upland Acres	
Purchased Projects	11	520.3	20	2,318.9	2,839.2
Conservation Easement Projects	0	0	0	0	0
Leased Projects	11	460.9	23	1,895.0	2,355.9
Management Agreement Projects	38	830.1	66	5,153.0	5,983.1
Conservation Agreement Projects	49	2,093.8	7	105.6	2,199.4
Total	**109**	**3,905.1**	**116**	**9,472.5**	**13,377.6**

NOTES:

1. Each project may contain several segments (Minimum 2) (i.e. a single project will contain at least one wetland segment and one upland segment)

2. Each segment on a project includes one habitat type or program type.

3. A single project may contain more than one wetland or upland segment (i.e. Idled pasture and introduced grass would be two separate upland segments)

Purchased Projects

Purchased projects are lands purchased and owned by Ducks Unlimited Canada and managed for wildlife. Some purchased land is cost shared and held by DUC and a partner including the Province's Fish and Wildlife Development Fund (FWDF). The following programs were carried out on DUC purchased properties:

- Idled Pasture
- Protect Native Grass
- Planted Dense Nesting Cover (DNC)
- Protect Small Wetland/Pothole Complexes

Properties purchased by DUC are actively managed using techniques that will maximize wildlife benefits while maintaining grass stand vigor. Management of purchased lands occurs when deemed necessary by DUC staff. Management such as haying or grazing is normally carried out by local producers through contracts under pre-established guidelines.

Conservation Easement Projects

A Conservation Easement is a voluntary legal agreement between a landowner and a government or qualified conservation organization, such as Ducks Unlimited Canada. A CE is intended to preserve the natural integrity of the land by limiting the amount and type of development that can occur on a property in the future. CE's are intended to secure and protect the following features:

- Protect Native Pasture
- Protect Small Wetland/Pothole Complexes

CE's can be either Paid or Donated depending on financial implications. The CE is registered on title and the term is perpetuity. The CE can be one of two different types depending on the landowner's intentions for future use of the land and environmental benefits of each CE.

a) Managed for Agriculture CE's allow landowners to maintain agricultural uses of the land such as haying and grazing. However, agricultural uses shall not include any destructive activities such as breaking, cultivation, burning or conversion on these lands. The landowner remains responsible for and has sole discretion over management decisions on the land.

b) Managed for Wildlife CE's optimize the land's habitat quality for wildlife and waterfowl habitat by placing management decisions in the hands of the CE holding agency (DUC).

Leased Projects

Leased projects are lands leased by Ducks Unlimited Canada from the legal landowner and managed for wildlife. The following programs were carried out under lease agreements:

- Idled Pasture
- Protect Native Grass
- Planted Dense Nesting Cover (DNC)
- Protect Small Wetland/Pothole Complexes

The lease agreement used to secure this habitat was signed between the legal landowner and Ducks Unlimited Canada. Lease terms were normally 10 years in length and the landowner retains title to land. The land being leased is idled but haying and grazing can be carried out by DUC when required to manage the habitat.

Management Agreement Projects

Management Agreement Projects include DUC's agricultural programs and any wetlands protected along with them. The following programs are completed using Management Agreements:

- Salinity Program
- Grazing Systems
- Convert to Grazing System
- Deferred Grazing Native Pasture
- Deferred Tame Forage
- Native Prairie
- Convert to Forage Hay
- Winter Wheat Program
- Protect Small Wetland/Pothole Complexes

Habitat was secured under these programs using a Management Agreement signed between the legal landowner and Ducks Unlimited Canada. Agreement terms vary from 7 years to 21 years depending on the program type and ensure that the upland and wetland will remain for the term of the agreement. The landowner retains title to the land and agricultural practices may occur on the project in accordance with the agreement. The portion of the project cost picked up by DUC varies with each different program.

Conservation Agreement Projects

Conservation Agreement Projects include all of DUC's larger wetland projects constructed from 1938 to present and any associated upland areas secured as buffers around the large wetlands. They include the following Securement types:

- Large Wetlands (No control structure)
- Water Control Structures
- Idled Pasture

These large wetland projects were secured using a Conservation Agreement signed between the legal landowner and Ducks Unlimited Canada. Agreement terms vary from 21 years to perpetuity depending on when the project was constructed and ensures that the wetland will remain and be managed for wildlife for the term of the agreement. The landowner retains title to the land and grants DUC the right to operate and manage the project. DUC is responsible for all costs associated with the installation and maintenance of any works within the project.

The Benefit of DUC's Programs to Source Water Protection

Wetlands, riparian buffers and uplands are vital components of watersheds and freshwater resource sustainability in Saskatchewan.

Wetlands Projects

The hydrological functions of wetlands include storage and eventual release of surface water, recharge of local and regional groundwater supplies, reduction in peak floodwater flows, de-synchronization of flood peaks, and erosion prevention. Position in the landscape, location of the water table, soil permeability, slope, and moisture conditions all influence the ability of wetlands to attenuate floodwaters. Wetland drainage reduces the capability of a watershed to attenuate runoff during flood conditions.
Maintaining and restoring wetlands on the landscape reduces overland flow rates and therefore potential flooding.

Recharge of groundwater is an extremely important function of some wetlands; water percolates slowly from wetlands to aquifers. Interactions between wetlands and local or regional groundwater supplies are complex and site-specific and affected by the position of the wetland with respect to groundwater flow systems, geologic characteristics of the substrate, and climate.

Although not all wetlands directly recharge groundwater aquifers, their role in source water protection is just as important. The numerous small wetlands, which are typical throughout the Lower Souris River Watershed, can be effective nitrate sinks in agricultural landscapes (over 80% removal). Phosphorus retention in wetlands can also be significant (up to 94%) and is accomplished through adsorption onto particles, precipitation with metals and incorporation into living biomass. Removal of these wetlands through drainage activities or filling in not only remove their ability to store runoff in small events, but allow the sediment and potential contaminants that would normally be contained in them to pass downstream into larger wetlands or streams where recharge of aquifers does occur or water is drawn directly withdrawn for human or livestock consumption.

The document "***The Role of Canadian Wetlands for Improving Water Quality***, *A review of the biological and economic values wetlands provide to society and environment" by Lisette Ross, Ducks Unlimited Canada*" provides more detailed information on the role wetlands play in source water.

Riparian Buffer Projects

Vegetated buffer strips can effectively control erosion by forming a physical barrier that slows the surface flow of sediment and debris, by stabilizing wetland edges and stream banks, and by promoting infiltration. The required width of a buffer size is determined by the type of vegetation present; the extent and impact of the adjacent land use; and the functional value of the receiving wetland. Studies have found the bulk of sediment removal occurs in the first few meters of the buffer zone; sediment removal can be 75-97%.

Buffer strips can effectively remove nutrients from surface water flow. The main mechanisms of nitrate removal are by vegetation uptake in the roots and anaerobic microbial denitrification in the saturated zone of the soil. Relatively narrow buffers seem to be very (35-96%) effective in reducing nitrogen.

Phosphorus retention can be effective (27-97%) in buffer strips that contain both woody and herbaceous vegetation, grasses and cropped buffer systems. Buffer strips can trap a significant proportion of pathogens (up to 74% of fecal coliforms); however, remaining levels often exceed minimum drinking water standards. Low soil moisture and high soil temperature substantially decrease survival of total and fecal coliform bacteria. The key process for pesticide retention in buffer strips is infiltration. Grass buffer strips can reduce pesticides by 8-100%.

Upland Cover Projects

Upland conservation programs, such as no-till and permanent perennial cover, slow surface runoff, trap sediments and promote infiltration, consequently reducing the amount of sediments, nutrients and pesticides that enter the watershed.

The most beneficial outcome from implementing practices such as conservation tillage and permanent perennial cover is erosion reduction. Erosion from wind, rain and runoff can be reduced up to 99% because of greater site stability, infiltration and protection as a result of surface crop residue and perennial vegetation.

Upland cover has shown to be effective in reducing the amounts of nitrogen (up to 90%), phosphorus (up to 91%) and pesticides (up to 100%) in runoff but there is potential for increased leaching through the soil profile to groundwater. Although conservation tillage has not always reduced nutrient and pesticide leaching, this practice is recommended because the benefits outweigh the potential drawbacks. With respect to perennial upland cover, this land has been removed from production, resulting in fewer pesticides and fertilizer nutrients applied and subsequently released. Currently there is insufficient information regarding upland conservation practices and pathogen movement.